# THE ALLAHABAD FARMER

## A BI-MONTHLY JOURNAL OF AGRICULTURE AND RURAL LIFE



The ALLAHABAD FARMER is now approved by the Directors of Public Instruction in the United Provinces, Bengal, Central Provinces, Sind, Assam, Bihar and Orissa, the Rural Reconstruction Commissioner, Punjab, and by the Director of the Institute of Plant Industry, Indore, and Agricultural Adviser to Rajputana and Central India States, for use in all schools under their jurisdiction.

### Subscription Rates

Annual subscription : India, Rs. 3; England, 4 shillings; U.S.A., 1 dollar. Single copies, 10 annas; over five years old, 12 annas Copies which are not received by subscribers will be supplied free of cost within six months of the month of issue. Thereafter single copy prices will be charged.

Unused portions of subscriptions cannot be refunded.

### Advertising Rates

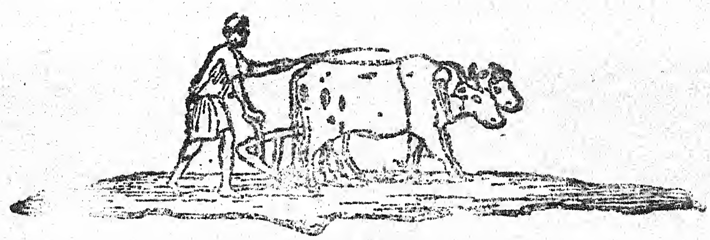
| | Rs. | a. | p. |
|---|---|---|---|
| One full page of six numbers .. .. .. | 35 | 0 | 0 |
| One single full page .. .. .. .. | 7 | 0 | 0 |
| One half page of six numbers .. .. .. | 20 | 0 | 0 |
| One single half page .. .. .. | 4 | 0 | 0 |
| Page 2 or 3 of cover for six numbers .. .. | 50 | 0 | 0 |
| Page 4 of cover for six numbers .. .. .. | 70 | 0 | 0 |

### Contributions

The ALLAHABAD FARMER is published in the first week of each alternate month commencing with the month of January. Contributors are requested to send in their articles at least one month prior to the next prospective date of publication.

Contributors will receive 15 reprints of the article published and additional copies at cost.

# THE ALLAHABAD FARMER



VOL. XIX] JANUARY, 1945 [ No. 6

## Editorial

This issue of the Allahabad Farmer is a special number devoted especially to horticultural subjects. The articles have been collected by members of the executive committee of the Horticultural Society, Allahabad Agricultural Institute; and we have no hesitation in publishing them and in giving the whole issue to these articles as we believe that the development of horticulture in this province, as well as in this country, on modern scientific lines, more or less in the way that it is practised in other, more advanced, countries of the world, is long overdue.

In July 1934 we wrote in our leading editorial in part as follows:—"We have no doubt at all that there is much room for the development of this (the fruit) industry not only in these provinces, but in the whole of India." We then asked, "What justification is there for the import of tinned pine-apples fror Hawaii when there are places in India where better pine-apples can be rais than those we get from Hawaii? Or what justification is there for the import Del Monte fruit products from California, or of Bartlett pears from Australia c of fresh, nice-looking but insipid apples from Japan, when Kashmir and some of our hill sections can produce these fruits which are in no way inferior to those we get from those countries?" We asked further, "Hasn't India also some of the best mangoes and the best guavas ever produced? But are the Indian cultivators, as a rule, growing the best varieties of these fruits? Isn't it almost the rule, on the other hand, to grow the poorest mangoes throughout our villages?" We then suggested certain lines that might be followed by agricultural departments in order to speed up the development of fruit cultivation and fruit industries in the country. Among the suggestions made were the following: (1) the appointment of fruit specialists as had already been done in the Punjab, (2) the provision of better storage facilities during transportation by rail, (3) grading and standardization, and (4) the setting up of fruit products laboratories in existing agricultural colleges.

While some provinces and states have taken steps to improve the fruit industry in their respective areas, yet, on the whole, we do not hesitate to say that the attempts have been very feeble. India which may be the ancestral home of many citrus fruits now consumes, on the average, about 3.2 lbs. per capita per

year. Spain consumes 85.0 lbs., the United States of America 54.3 lbs., United Kingdom 27.0 lbs. and Palestine 222.0 lbs. Thus India, judging from the above statistics, consumes much less fruit than several other countries of the world. For the improvement of the national health of the country it is very important that the consumption of fruits per capita should be increased. We believe that the per capita consumption in this country has seriously decreased during the last few years as the result of this war.

Knowing that this country has vast stretches of land which are suitable for the growing of all kinds of fruits, such as apples, apricots, plums, cherries, pears, mangoes, grapes, grape-fruit, lemons, limes, litchis, loquats, pomegranates, strawberries, pineapples, oranges, custardapples, papayas, guavas, melons, watermelons, jujubes, *chironji*, and phalsa ; and knowing that the present output is extremely inadequate to meet the requirements of the country, we feel that the nation should pay more attention to the development of this industry in the country. Increased production by the improvement of cultural methods and the growing of suitable varieties will also go a long way towards the reduction in price of the fruits so as to make them come within the easy reach of every person in the country.

---

## REPORT OF THE HORTICULTURAL SOCIETY OF THE ALLAHABAD AGRICULTURAL INSTITUTE.

By S. R. Barooah, B.Sc. (Ag.), M.Sc. (Ag. Bot).
*President, Horticultural Society.*

The Horticultural Society of the Allahabad Agricultural Institute owes its origin to the seminar classes of the pomology students. The enthusiastic students of the pomology group started the Society in March 1943 with the object of exchanging views and increasing their knowledge of horticulture. The Horticultural Society was inaugurated by Dr. Sam Higginbottom who wished the Society a long and prosperous life. Since then the Society has been functioning smoothly under the able guidance of Mr. Hayes who was the president for the year 1943-44. The society owes its growth and development to the untiring efforts of Mr. Syamji Taunk and Mr. T. A. Jacob.

In the first year of its life the primary object was to arrange lectures for the benefit of the members. Many lectures were delivered by reputed men of science and arts. The principal speakers of last year were Dr. B K. Malvea on 'Citriculture,' Dr. S. S. Prabhu on 'Genetics and Horticulture,' Mr. A. Dayal Chand on 'The Scope of Fruit Preservation in India,' Dr. T. W. Millen on 'Bee Keeping and Horticulture,' Mrs. Gould on 'Landscape Gardening,' Dr. B. B. Malvea on 'Recent Researches on the Vitamin Content of Indian Fruits,' and Justice Yorke on 'Gardening.' All the lectures were of a very high standard and were appreciated by all. A Horticultural number as a special issue of the Allahabad Farmer was also published which gave a number of articles of horticultural interest. We are very grateful to the Editor of the Allahabad Farmer for this act of kindness.

The second year of the Horticultural Society began after the first annual function of the Horticultural Society which was presided over by Mr. Hayes, the outgoing president. New elections were held and the following were elected office-bearers : Mr. S. R. Barooah, president, Mr. K. B. Mathur, Vice-President, Mr. M. A. Khan, Secretary-treasurer, Mr. S. M. S. Khan, Joint Secretary and Mr. B. R. Deka, additional member of the executive committee. Due to some personal reasons the Secretary resigned, and the vice-president left the Institute. In their place Mr. H. R. Khan and Mr. D. R. Singh have been elected as vice-

president and secretary respectively. The most unfortunate incident is the untimely and sad death of Mr. B. R. Deka. He was a very useful member of the Society.

The second session of the Horticultural Society was inaugurated by Prof. Sri Ranjan, the Dean of the Faculty of Science, Allahabad University. He spoke very highly of the Society because within one year the Society had grown to 70 members. On the same occasion Mr. S. R. Barooah, the President, delivered a lecture on the 'Romance of Temperature and Light in Agriculture' which was illustrated. The subject was a part of his research work which he is doing in the University for his Ph. D. degree. In this lecture he explained the possibilities of 'vernalization' for Indian agriculture.

The second lecture of the session was by Mr. A. Dayal Chand on the "Fruit Industry in the United Provinces". This was the first of the series, and he will deliver one more lecture at a later date. He dealt with facts responsible for the unhealthy growth of fruit trees in the U. P. He also very elaborately explained bad orchard practices and suggested methods of improvement.

Along with the arranging of lectures for the benefit of members, the Society has also taken up many new enterprises. One of the new projects is competitive seminar lectures among the members and it was decided to award prizes for the three best speakers. This project received a good response and some ten members gave their names for speaking. Two members have already spoken and the rest of the lectures will be arranged soon. This was started with the object of cultivating the habit of speaking in public on a scientific subject. This also encourages the speakers to read outside journals.

The Society has got many more projects such as an essay competition and a competition on budding, but due to shortage of time many of these have had to be abandoned. For all these activities I am grateful to the members of the Society, the executive committee members and the speakers who have encouraged us in our activities.

## PRUNING THE GUAVA*

By W. B. Hayes,

*Agricultural Institute, Allahabad.*

The guava, *Psidium guajava* Linn., is an important fruit in various parts of India, and especially in the United Provinces, where it ranks next to the mango in acreage, with a total of more than 58,000 acres (Dayal Chand, 1943). It is a very hardy fruit and is commonly grown without irrigation and with very little cultural attention. However, proper care is rewarded with larger crops of better quality fruit and a longer life. It is to be regretted that this popular fruit has been the subject of very little scientific investigation.

In Allahabad district, an important centre of guava production, the trees are commonly planted from 12 to 18 feet apart. The first few years an intercrop is grown, after which the trees receive very little cultivation. Some orchards are irrigated, but many are not. Pruning is ordinarily limited to the chopping off of broken or dead branches. Fair crops are secured, especially from the irrigated orchards, but in many cases the life of the orchards is only 10 or 15 years. By that time crowding is reducing the yield. In some of the older orchards, bearing is limited almost entirely to the tops of the trees, where the fruit is more readily available to birds and bats than to the owners.

*Reprinted from the Indian Journal of Horticulture, Vol. I, No. 2.

## Heavy Pruning in Bombay.

A promising method of treating guavas so as to make close planting possible without too great crowding was reported by Cheema and Deshmukh (1927). Trees were planted 15 feet apart and were heavily pruned in May, the entire growth of the last season being removed except for a stub with one or two buds. Other trees, planted 20 feet apart, were left unpruned. Figures are given on the yield, presumably for one year, of the 600 trees in the experiment. The age of the trees is not stated. The unpruned trees produced 464 fruits per tree, weighing 45.4 lb. This works out to 4,949 lb. per acre, or 1.57 oz. per fruit. The pruned trees bore only 234 fruits per tree, but these weighed 2.27 oz. per fruit, or 33.2 lb. per tree, or 6,441 lb. per acre. Thus the pruned trees produced about 30% more fruit per acre, and as the fruit was larger, the increased value of the crop was more than one-third. These results seem very encouraging, although, as the senior author has pointed out in private correspondence, no definite recommendation was made. The method seems not to have been adopted by the growers of Bombay.

A very similar method of pruning was recommended to growers in the United Province's by Smith (1934). He advocates planting the trees 15 feet apart, and although the monsoon begins later there than in Bombay, states that the pruning should be done in April or May. No mention is made of the Bombay experiment, but one suspects that its results are the basis for the recommendation in the United Provinces. Probably the method had not been tried in the U. P. at the time the bulletin advocating it was published.

## Material and Methods.

In 1934 an experimental plot was planted at the Allahabad Agricultural Institute. Nearly 200 seedling trees were planted, half of them 15 feet apart and half 25 feet apart, by the hexagonal method. The trees were raised from seed taken from one uniform lot of the finest quality white-fleshed guavas. One purpose was to find out how much variation there would be among trees grown in this way. Experience showed that while the trees grew normally, and the fruit was all of a fairly satisfactory quality, there was large variation in the vigour of growth, in the size, shape, and quality of the fruit, and in the time of ripening.

The trees were planted in a sloping field, on sandy-loam soil, conditions which are ordinarily satisfactory for guavas. Unfortunately, the Jumna river that season reached the highest level of the last 25 years, flooding the lower part of the orchard for several days. This damaged some of the trees. A few months later there was a rather severe frost which again damaged the trees in the lower part of the field. Some of them were killed outright, and some to the ground. Where shoots came up from the base of the tree, one was kept and made into a new trunk. Dead trees were replaced with similar seedlings. This left the lower corner of the field considerably behind the rest, and with trees very uneven in size.

During the first few years, the trees were all treated alike. Clean cultivation has been carried out each year except during the monsoon season, when a cover crop is grown. The trees were irrigated throughout the year until they became well established; since then only from the end of the monsoon until January, so that no deficiency of water occurs while the fruit is on the trees. During the summer the ground becomes dry and the trees shed a large part of their leaves. The irrigation water is sullage from the city of Allahabad, but aside from this and the green manuring, no manure is used. All of the trees were pruned so as to provide a reasonably strong framework, with the lowest branch about a foot and a half from the ground.

Neither Cheema and Dashmukh nor Smith indicates the age at which the severe pruning is to be started. As the reason for the increased yield in Bombay was the larger number of trees per acre, the trees in this experiment were allowed to grow normally until those in the 15-foot block began to crowd each other. Since that time, nine rows in this block have been pruned annually, leaving only a stub about three inches long from the previous season's growth. Four rows in this block, and the entire 25-foot block have been given only the light pruning necessary to remove broken or interfering branches, or to shorten those which are likely to bend badly or break.

The heavily pruned trees are divided into three sets of three rows each with eight trees in each row. One set has been pruned the first of May, one the first of June, and one the first of July, each year. Severe sunburn of the bark followed the first pruning of the trees pruned May 1. While there has been little evidence of damage in other years, these trees have never recovered, and the decay which started where the bark was killed has continued, and has practically destroyed some of the trees.

Accurate records on the yield of the orchard could only be obtained by counting and weighing the fruit from each tree each time any fruit was removed, which would have involved great expense. The most economical way to sell the fruit of this orchard has been to sell it to a contractor at the beginning of the season. Each year, at the beginning of the season, a class of students has gone through the orchard, each student making an independent estimate of the number of fruits on each tree. The average of the estimates of all the students for any tree is taken as the number of fruits on that tree. Unfortunately, complete records have not been kept, but records are now available for all the trees planted 15 feet apart for the four years, 1939-42. There are also records for certain trees selected at random in the 25-foot block in 1939 and 1941, and for all of the trees in 1942. The estimation of the number of fruits on the larger trees is obviously more difficult than on the smaller trees, especially when the number on the latter is less than 100, as is commonly the case. The tendency of the students was probably to under-estimate the number of fruits in the 25-foot block.

## Results.

Among the heavily pruned trees, planted 15 feet apart, during the period 1939-42, the highest estimated yield in one year is 288 fruits, while the average for all these trees is only 61 fruits per tree per annum. While the trees pruned on June 1 average somewhat higher in yield than those pruned earlier or later, the difference is not large or consistent. The sunburn suffered by the trees pruned on May 1 is probably the main reason why they produced less than those pruned on June 1. This condition is reflected in the sharp decline in the yield of the trees pruned on May 1, from year to year. This decline is less marked in the rest of the heavily pruned trees, but the total yield in the last two years is less than half that of the first two. This does not encourage one to expect better results in the future.

The most striking feature, however, is the very low yield of the heavily pruned trees, both absolutely, and in comparison with the lightly pruned trees. The lightly pruned trees in the 15-foot block produced during the four years nearly five times as many fruits as the heavily pruned trees. The average number of fruits estimated on each tree in the 25-foot block is 446, but this block includes trees damaged by flood and frost. The average for the lower three rows, in which many trees were damaged, is only 325 fruits, while the upper four rows average 562. The latter figure is probably a fairer one to use for comparisons. The trees chosen at random in 1939 and 1941 averaged 553 and 580 fruits respectively. These trees in the 25-foot block are still growing, and can be expected to bear larger crops each year for several years to come.

From time to time during the harvesting season, fruits harvested from the trees under different treatments have been weighed and measured. While the reults are not entirely consistent, it is clear that the heavily pruned trees have produced the largest fruit, averaging 5.3 oz. as compared with 4.4 oz. on the trees 25 feet apart, and 3.6 oz. on the lightly pruned trees in the 15-foot block. The differences in the weight of fruit per tree or per acre are not great among the heavily pruned trees, but are very striking between the heavily and the lightly pruned trees. The total production per acre of the heavily pruned trees is less than half of that of the others. Up to the present, the production of the lightly pruned trees planted 15 feet apart is greater than that of those planted 25 feet apart. But crowding is already great enough, with the trees only nine years old, to make cultivation with oxen impracticable, and some of the lower branches have died from too much shade. These trees have probably reached their period of maximum bearing, and will soon decline, while the trees 25 feet apart have the better part of their lives before them. The outside trees in the lightly pruned 15-foot block have suffered much less from crowding, and have borne larger crops. If these were eliminated, the yield per acre would be approximately the same as in the 25-foot block.

It is, perhaps, too early to reach any final conclusion regarding the best spacing for trees under the conditions of this experiment, but it now seems clear that in this experiment heavy pruning of the type described has been undesirable. Until there is some experimental evidence in favour of this method in northern India, it would seem unwise to recommend it to the growers.

## Summary.

Seedling guavas were planted in Allahabad in 1934. Half were planted 25 feet apart and pruned only lightly. The others were planted 15 feet apart and pruned heavily, in order to avoid excessive crowding, as recommended by Smith. The heavily pruned trees produced larger fruits, but the number per tree was so low that the yield per acre has been less than half of that of the lightly pruned trees. The heavy pruning has thus proved entirely uneconomical.

### REFERENCES.

Cheema, G.S. and Deshmukh. G. B. (1927) : Culture of Guava and its Improvement by Selection in Western India. Dept. Agri., Bombay, Bul. No. 148.

Dayal Chand, A. (1943) : Agricultural Institute, Allahabad, Unpublished survey.

Smith, W. S. (1934) : The Guava. United Provinces Dept. Agr. Fruit Series Bul. No. 8.

# SPOILAGE OF FRUIT PRODUCTS.

By K. C. Batra, B.Sc. (Hons), Assoc. I. A. R. I.

*Chemist, G. G. Fruit Preserving Factory, Agra.*

The rapid progress of the fruit preservation industry in India during the war as a result of falling off of imports and the increased demaud for the defence services as well as civilian consumption has led to many interesting problems. Most significant of these is the total disregard by many of the quality of products put on the market. It often becomes extremely difficult for a consumer to put his hand on the genuine and nutritious type of product he needs. Some unscruplous manufacturers taking advantage of the heavy demand for fruit products and of the fact that almost all the reputed manufacturers are engaged in military contracts, have lost sight of the essential back-ground of quality and put forth their products at comparatively such cheap prices in the market that both the dealer and consumer are tempted to patronise their brands. Although

the Central Agricultural Marketing Department contemplates stopping this malpractice, as yet nothing has been done. The high prices demanded by the genuine manufacturers on the other hand are due to a multiplicity of reasons. Among these may be included—(1) the increased cost of raw material and skilled labour, (2) the excessive cost of transport and the enhanced transport difficulties, thus allowing the release of only a restricted quota at a time, (3) the increased demand by military and other defence services, (4) the non-availability of proper equipment and the consequent inability to increase production, (5) in certain cases the wrong location of the factories, some of these being far away from the main fruit producing areas and (6) the high spoilage in the fruit products manufactured at the present time in the country. It is with the causes and prevention of spoilage that the author will deal at length in this article.

If we look into the history of the development of this industry in the U. S. A. and other foreign countries and compare it with that in India, we find a striking similarity. Today we notice here much the same troubles as were experienced by promoters of this industry in the U. S. A. in the beginning. Ola Powell Malcolm in her book 'Successful Canning and Preserving' sums up the position of the industry in the U. S. A. round about the year 1900 thus :—

'The canner really knew so little about the science that he felt compelled to guard carefully his ignorance. He tried to throw a glamour of secrecy over nearly every movement simply through caution to protect what little good information he possessed regarding the process of canning. The uncertainty and the possibilities that losses might occur were a constant source of worry and uneasiness to a great many who were engaged in the canning business.' This statement, modified a little, portrays very well the picture of the fruit canning industry in India at the present moment. It was only by eradicating the various causes of spoilage and a thorough study of the underlying causes that canners in foreign countries increased their production to such tremendous figures. No doubt, the favourable policy of their Governments went a long way to establish the industry on sound lines. An important problem for fruit preservers at the moment is to keep the spoilage figures in their products as low as possible. The first essential check in this direction is the maintenance of proper and accurate records of spoilage and if practicable of the underlying cause. The spoilage figures reviewed from year to year will give a fair idea of the progress being made.

Spoilage may be of various kinds and of different magnitudes in fruit products. It is for most purposes restricted to fermentation and mould growth excepting in tinned products where we meet with other types such as 'Hydrogen swells' and metallic contamination. Fermentation, as we know, is by the action of yeasts on sugar, converting the latter into carbon di oxide and alcohol. These grow most in the presence of air, warmth and moisture, and require food in the form of sugar for their activity. The easiest way to detect fermentation is to ascertain the presence of alcohol and carbon dioxide gas. Bubbles of this gas may be seen when a can of fruit ferments. Since yeasts are abundant in the air and on the skins of fruits, it is necessary to destroy them by heating or cooking the product at a temperature of 160°—190° F for about one hour. Molds require oxygen, considerable moisture and heat for their growth, and use sug ar, starches, and protein as food ; moreover, they can grow in the presence of acids. Because they have the ability to grow in acids molds readily attack tomatoes. Mold is recognised either by a black growth or a white cotton like formation on the top of the contents in the bottle. While fermentation takes place throughout the product, mold growth takes place only on the top. Necessarily, fermentation is mainly restricted to jams, jellies and squashes while tomato ketchup and lime juice cordial are prone to the attack of molds. 'Hydrogen Swells' are due to the

action of fruit juices on the tinplate while metallic contamination depends on the extent of metals dissolved by the canned product from the can. Tin is the metal most usually taken up. Higher values have been found for dissolved tin in unlacquered cans than in lacquered ones and higher for once lacquered than for double lacquered cans.

Various causes may be responsible for the spoilage. Important among these may be (1) improper sterilisation and exhaust, 2) the use of over-ripe fruit (3) the use of a highly acidic variety of fruit, the acid in which in case of jams may act upon the tinplate of the can, thus producing swelling and other troubles, (4) leaky cans, (5) poor quality of tinplate, (6) low temperature of filling, (7) an improper amount of headspace in case of canned products, (8) improper capping in case of bottled products, (9) improper cooling of canned products before stacking and (10) exposure to air and moisture of the finished products. We take up the causes under different heads one by one below:—

(1) Improper sterilisation and exhaust.—The idea of sterilising an empty bottle or can of the finished product is to kill the harmful micro-organisms present. The thermal death point of each of these is different, hence proper care should be taken to see that no spoilage occurs through the survival of these organisms in preserved fruit products. The time of sterilisation varies with the kind of fruit used and the climate of the place at which the goods are manufactured. It has been long recognised that acid fruits require less time for sterilisation. More often than not a fruit preserver is likely to take the time for sterilisation given in different texts as true for his products—a notion in which he may be mistaken.

Exhaust means the removal of air in the headspace after the can has been filled. An imperfect exhaust may lead to discoloration of the product, aerobic bacterial growth and corrosion of the can. Exhaust is usually done by passing the filled cans with their lids clinched either through hot water or steam heated coils at 180°—190° F in case of fruit products, for a period depending on the size of can and the nature of the material packed. A liquid pack will take less time for a certain temperature to reach the centre of the can than a semi-solid or a solid pack. Similarly, the time given for exhaust will vary with the concentration of the syrup or the percentage of sugar in the pack.

(2) Use of over-ripe fruit.—In most of the factories which wish to keep the cost of production low, over-ripe fruit is being used. In 99% of the cases trouble is bound to arise sooner or later if this kind of fruit is used. The experience of packers has proved that products containing a large percentage of decomposing material, due to the activity of micro-organisms, are very much more difficult to process than the same products in a sound condition. Over-ripe fruit because of the fact that it softens and forms a compact mass in the can and retards the penetration of heat, is much more difficult to process than fruit of firm texture. Moreover, such fruit contains very little pectin, so essential for jellying power. Factories far away from the fruit producing centres are most tempted to use damaged or over-ripe fruit because of enormous loss during transit.

(3) Use of highly acidic fruit in jams—The comparison of analysis of acidity of Indian fruits with those being used in foreign countries shows our fruits to be more acidic and especially so when these are under-ripe or green. While acidity in jams is desirable to some extent so as to prevent the growth of micro-organisms, this, beyond a certain limit (·45% acidity as eq. citric acid anhydrous) produces hydrogen by its action on exposed iron in the tinplate and thus swelling may be produced and the product be spoiled. The tinplate available now-a-days especially is of a very poor quality and care should be taken to select fruit of such variety and maturity as is the least acidic. Just ripe fruit is the best.

(4) Leaky Cans—This is the trouble most prevalent in fruit factories dealing with canned product. Leakage may be due to faulty seaming, perforation of the walls of the can as a result of 'Hydrogen Swell' or an imperfect soldering across the joint of the can. If at any stage the can is leaky, air and moisture, the two intimate friends of various micro-organisms, are likely to get in and spoil the product. The easiest method to detect leakage in a closed can is to put it in hot water kept near its boiling point and to note the evolution of bubbles from the surface of the can. This fact can further be confirmed by testing for vacuum in the can by a vacuum guage. If there is any suspicion of a leakage, invariably the guage will show no vacuum. On the other hand, the mere fact that there is no vacuum does not mean definite leakage.

(5) Poor quality of tinplate—By poor quality of tinplate is meant a plate with an uneven coating of tin and having spot of exposed iron. Such tinplate, as has been pointed out, is liable to attack by the acid at the earliest moment and the result is the puffing up of the can. In the presence of air this attack proceeds more vigorously. The comparative susceptibility of a can to hydrogen swell can best be judged by a test known as the ferricyanide-gelatin test.

(6) Low temperature of filling—The temperature of the product at which it is filled in the can or bottle is an important factor in the spoilage of fruit products. Filling at a high temperature has the advantage of exclusion of any dissolved air which may afterwards prove to be the source of spoilage. The finished product if allowed to cool below 185°F or so before being filled in the cans has every chance to absorb air during the process of cooling. This air acts as an impetus for micro-organic activity, thereby inducing early spoilage. This observation is of great value in the long run and a small experiment should be planned in individual cases to fix the optimum temperature of filling.

(7) Improper amount of headspace in canned products—The amount of space to be left at the top of a can should be such as to permit a little hydrogen which is being produced continually by the corrosion of the can, and to allow for expansion of the food but not so much as to allow the possibility of the air being enclosed in the can. In case of too much or too little space, spoilage will result. A headspace of 1/8″—3/16″ is a safe goal in the author's opinion.

(8) Improper capping in case of bottled products.—The capping in case of bottled products should be absolutely airtight to serve as a guard against damage by the entry of outside moisture and air. This precaution should be strictly observed in the case of crown corks and especially for tomato ketchup, tomato juice and other fruit juices bottled without any preservative.

(9) Improper cooling of canned products before stacking—Cool cans as quickly as possible after processing and seaming. This ensures better keeping quality of the pack, preserves the natural flavour more efficiently and is a natural guard against overcooking during processing. For this operation a spray is more useful than any other device. Never stack cans together until entirely cold. The cans should, however, be dried before storing to prevent rusting.

(10) Exposure to air and moisture of the finished products.—As soon as the products are prepared, these should be immediately bottled or canned and made impervious to the entry of air and moisture in order to exclude any possibility of spoilage by this means. In big factories, on account of huge production, it often happens that the product is kept lying on the filling tables for a good deal of time before the filling is undertaken. In such cases, besides the exposure to air and moisture of the finished products, the temperature of filling is likely to be low. This is detrimental and brings about early spoilage.

The author is of the firm belief that if proper attention is directed to keeping spoilage at a minimum, it becomes very easy to increase production. We have a difficult task ahead—that of facing competition with imported products in the post-war period. No amount of scientific work or experience in the line can prove helpful if there is no protection given to this industry by our Government at this stage and in the future. Meanwhile, we should not forget the improvements we can affect by perfecting the various operations. The work done in the U.S.A. and other foreign countries can be taken as our starting point. No doubt, we haae our own specific problems but the underlying scientific principles are essentially the same. The energies of the various fruit laboratories in India should be focussed on the main problems confronting the preservation industry rather than on propaganda work, the time for which is already past. With a co-ordination of well planned research and the helpful attitude of the Government of our country, the future of the industry is assured.

## VEGETABLE SEED GROWING

By Mohammad Hamza Hashmi, B. Sc. (Ag.)

*Department of Horticulture, Allahabad Agricultural Institute*

The war has given a great impetus to the seed growing industry in India. An acute shortage of food supplies has resulted in the organization of Grow More Food Campaigns in the various parts of the country.

In this connection, several vegetable expansion schemes have sprung up and the provincial Departments of Agriculture have tried their best to produce more and more vegetables for the army. On the other hand, the importation of foreign seeds having been practically stopped, the problem of securing seeds has become quite complicated. The limited number of vegetable seedsmen of the pre-war days could not possibly meet this unexpected demand for seeds. Accordingly, several new dealers in vegetable seeds have started this business, most of them being not at all seedsmen in the true technical sense of the word. It may be well and good as a temporary solution for the present situation in vegetable gardening, but cannot be regarded by any means as a sound agricultural policy for the normal or the post-war period.

Vegetable growers of the modern era have by this time fully realized the worth of this specialized branch of gardening and are convinced that none but the best seeds are good to buy. Smith writes, "......For successful gardening, no point is of more importance than that the seed procured for sowing should be both sound and of the finest kind." A comparative study of the history of seed growing industry reveals the stages in the progress of this specialized type of work and the changes in the opinion of vegetable growers based on experience. In the years 1794 and 1795 Washington wrote to the foreman of his estate at Mount Vernon, "It is certainly a reflection upon a farmer to have his seeds to buy." It was then considered shameful for gardeners and farmers to purchase seeds which could be collected and saved on their own land. Later on, this idea was given up as Bailey points out in his book on Principles of Vegetable Gardening.—"In the old time it was considered to be sufficient if one saved his seeds, in the present time the mere saving is of little avail; he must breed his seeds."

According to M. G. Kains, "Seed growing and saving are such highly specialized forms of business and demand such intimate knowledge of the plant in question,..............................................................................that the grower of vegetables for sale may well leave it to the specialists who devote their lives to it . . . . . . . This is a branch of work, which to get best results demands at least a working knowledge of plant breeding." Bailey also regards seed growing to be a costly business requiring experience and a man's undivided

attention. It is therefore advisable that only those should enter this business who are really interested in the art and science of plant improvement and possess a working knowledge of plant breeding problems. A seed grower must always bear in mind the following factors for the success of his enterprise :—

1. He must have an ideal and must work to it.
2. Plants which do not meet the breeder's ideal must be pulled out and discarded. This is known as roguing.
3. He must know the market demand.
4. He must know what his customers want.
5. He must know what will be most desirable and useful under the greatest number of conditions.
6. He must know what is likely to show the most stable and the least variable character.
7. The seed breeder must stick to his ideal and should discard every other plant which does not reach his standard, once set up.

For a seed grower the knowledge of plant breeding is absolutely necessary. He may not be exactly a plant breeder, but the fundamental principles of plant breeding must be clearly understood by him otherwise the slightest error on the part of the seed grower is likely to cause considerable loss to the customers as well as to his business. Reputation for genuine stock of standard varieties is an asset in seed growing industry. At the same time the importance of plant breeding in seed production work should not be over-emphasised. Hayes and Immer in 'Methods of Plant Breeding' remark, "Although a seed producer may undertake the problem of breeding in some cases, the primary task of the seedsman will be to produce high quality seeds of varieties and strains of known value." Now, the first step in producing good seeds is the selection of a variety or varieties to be grown. Such varieties or strains should be superior in the following respects : adaptability to the locality and soil conditions ; purity of type ; yielding capacity ; desirable characters ; resistance to diseases and insect pests. After the selection of the healthiest and most desirable plants of a variety the question of seed selection arises. To get an idea about the superiority of seeds the following points must be remembered : success in germination ; colour of seed and its weight ; uniformity ; freedom from seed-borne diseases ; freedom from weeds ; freedom from other marks of imperfection ; and freedom from mixtures with other varieties.

Vegetable breeding is a highly specialized type of work and its full discussion is beyond the scope of this article. Only those seed growers should go into details of breeding technique who aim at plant improvement, investigations for new varieties and search for disease resistants strains. Such improvements are possible by changing the hereditary constitution of the plant ; and the method employed is known as 'hybridization' which means the natural or artificial crossing of plants which differ from one another. The object is to combine in one individual or strain, characters found in two or more individuals or strains. There is much scope for plant improvement work with Indian vegetables. Briefly stating, examples of types of improvement are : resistance to the attack of insect pests and diseases ; improved qualities ; quick maturing varieties ; uniformity of shape and colour in root crops ; improvement in leafy vegetables ; and introduction of varieties specially suited to vegetable preservation factories.

The writer of this article was greatly impressed by the report on "Breeding and Improvement of Cucurbits" by T. W. Whitaker and I. C. Jagger published in the Year Book of Agriculture, 1937 (United States Department of Agriculture). The success of the work by J. T. Rosa and I. C. Jagger on

resistance to powdery mildew on muskmelon deserves full appreciation. For the information of the readers the central paragraph is reproduced here. "Twelve years ago, powdery mildew suddenly appeared in destructive form in melons in the Imperial Valley, Calif., the leading muskmelon producing section in the United States It could not be controlled by fungicides, and plant breeders began a search for disease-resistance material. In 3 years of careful testing they discovered several resistant varieties among melons imported from India. They were poor melons, but by suitable crosses their resistance to mildew was bred into good American varieties, and in another 4 years the first of the hybrids was released to California growers. Four more years of selection gave Powdery Mildew Resistant Cantaloup No. 45, which has superior shipping qualities in addition to disease resistance. This was released to growers in 1936, and the mildew problem is now largely solved in this area."

NOTE—The name "Cantaloup" is quite largely used in the United States to designate the small, oval, netted shipping type of muskmelon.

For large scale vegetable seed growing the most popular form of plant improvement work is done by 'mass selection.' It is the simplest type of selection 'by roguing out' or destroying all inferior and undesirable types from the crops and saving the mixed seeds from the remainder Roguing must be done before flowering so that no pollen from inferior plants takes part in fertilization. On the subject of mass selection Lawrence writes, "It is usually practised when seed of those annual or biennial plants which are usually propagated from seed is wanted in large quantities for trade purposes. The seed thus obtained is from open (chance) pollination,—*i.e.*, from self-or cross-pollination—hence the male parent is normally uncertain or unknown."......"In order to keep stocks true to type and maintain improvements, roguing should be scrupulously carried out every year, otherwise the strain will soon deteriorate, rogues usually being dominant forms." Paul Work in his publication on 'Tomato Production' also states, "Reapeated selection results in constant improvement until the stock becomes a 'pure line' or practically so."

Most of the cultural operations for seed growing will be the same as for general crops. Seedsmen have to be particularly careful when more than one variety of each vegetable is grown. The plots for different varieties of the same kind of vegetable must be separated from one another, for example if several varieties of lady's finger or okra are grown for seed, the blocks of each variety must be separated by at least ¼ (one-fourth) mile to prevent mixing. There is one more possibility. If several varieties are grown near one another, no seed should be saved except that produced by bagging and hand pollination. To get an idea about the yield of seeds and the area required for vegetable seed growing on a commercial scale, a table is given below for some of the vegetables according to Bailey. The column for yield shows the approximate outturn which seedsmen would expect in making contracts for large quantities.

| Name of Vegetables. | | Yield in lbs. per acre. |
|---|---|---|
| Bean | ... | 500 |
| Cabbage | ... | 200 |
| Cucumber | ... | 100 |
| Muskmelon | ... | 100 |
| Pea | ... | 800 |
| Sweet Corn | ... | 800 to 2000 |
| Tomato | ... | 100 |
| Watermelon | ... | 100 |

The seed should remain on the plant until fully ripe. The saving of unripe seeds may result in many failures later on. To keep well, seeds should be well matured. According to Rolfs, "Heat and damp together ruin nearly all seeds... ...Many seeds deteriorate on the voyage from temperate to tropical regions, unless

they are specially dried, stored in cans, and soldered up". In damp hot tropical climates seeds should be stored in stoppered jars or tin boxes, sealed with paraffin. If a package of fused calcium chloride or lumps of quicklime are placed with them to dry the seeds well, most of the seeds will endure such dessication without injury. Where cold storage facilities exist, seeds can be stored in water-tight boxes in the ice-house. The problem of keeping seeds in the hot regions of the world is of great importance to all agriculturists and should be dealt with according to the requirements of the locality.

Another information which might be useful to the seed growers is the longevity of seeds. Some seeds can be kept for 30 to 80 years or more retaining the germinating capacity but their vitality is greatly impaired. In tropical and sub-tropical countries most seeds lose their vitality particularly during the rains.

This rate of deterioration is much faster in tropical and sub-tropical regions than in-temperate regions. Vilmorin's Tables for the longevity of seeds is given below for some of the vegetables.

| Vegetable Seeds. | | Average Years. | Extreme Years. |
|---|---|---|---|
| Bean | ... | 3 | 8 |
| Beet | ... | 6 | 10+ |
| Cabbage | ... | 5 | 10 |
| Cauliflower | ... | 5 | 10 |
| Carrot | ... | 4 or 5 | 10+ |
| Coriander | ... | 6 | 8 |
| Cucumber | ... | 10 | 10+ |
| Egg plant | ... | 6 | 10 |
| Gourds | ... | 6 | 10+ |
| Maize | ... | 2 | 4 |
| Muskmelon | ... | 5 | 10+ |
| Okra | ... | 5 | 10+ |
| Onion | ... | 2 | 7 |
| Pea, garden | ... | 3 | 8 |
| Pumpkin | ... | 4 or 5 | 9 |
| Radish | ... | 5 | 10+ |
| Spinach | ... | 5 | 8 |
| Tomato | ... | 4 | 9 |
| Turnip | ... | 5 | 10+ |
| Watermelon | ... | 6 | 10+ |

In all seed growing work, seed testing is essential to save time and money. A simple process consists of putting 100 seeds within two folds of clean moist cloth, between two plates kept at a proper temperature. After a few days the number of seeds that form roots should be counted to get the percentage germination. In order to protect buyers from fraud, seed Control Laboratories should be established in all parts of the country under the direct supervision of the Departments of Agriculture for testing the vitality of seeds for sale and for examination regarding purity and other desirable characters. As acclimatized seeds give far better results than imported seeds, it is necessary that such arrangment should be made in all the representative zones.

From this brief discussion of some of the vegetable seed growing problems, it is evident that a lot of work has yet to be done in India to achieve best results. Much cannot be expected from private agencies in plant improvement work of this type as the industry is mainly in the hands of non-technical men with limited knowledge and resourses. What is needed is a well organised plan for such an improvement with technical leadership and Government aid. The Departments of Agriculture must take up this work on the lines of State Agricultural Experiment Stations in America for setting up standards of purity and quality. Simultaneously, Seed Growers' Associations should be formed in each province

or groups of districts to carry on multiplication work of standard and registered seeds in co-operation with the Government These Associations should enrol approved growers who possess the following qualifications:—

1. Willingness to co-operate with Government and other agencies for pure seed production.
2. Sufficient available clean land for seed production.
3. Accommodation for adequate seed—storage to avoid mixtures of seed.
4. Special suitability for crop improvement work.

The seed growing areas of all such approved growers must be inspected from time to time in different stages of the growing season for careful examination of standing crops and their behaviour. Finally, the sample of seed after harvesting should be analysed in the official Seed Laboratory and a certificate given if approved by the competent authority. In this way there can be a proper control over seed growing of known and desirable varieties to the entire satisfaction of the producer and the buyer. A spirit of competition among vegetable seed growers will thus be infused with the result that plant improvement work will be taken up in right earnest by really expert hands.

### References.

1. *Bailey, L. H.*—'The Principles of Vegetable Gardening' (pp 122-172).
2. *Rolfs, P. H.*—'Subtropical Vegetable Gardening' (pp 43-52).
3. *Sherrard-Smith, W.*—'Practical Hints on Flower & Vegetable Culture in India' (pp 3-4).
4. *Bailey, L. H.*—'Farm and Garden Rule Book' (p 105).
5. *Kains, M. G.*—'Five Acres and Independence' (pp 243- 252).
6. *Paul Work.*—'Tomato Production' (pp 117-120).
7. *Hayes and Immer.*—'Methods of Plant Breeding' (pp 263-279).
8. *Lawrence, W. J. C.*—'Practical Plant Breeding.'
9. *Beattie, W. R.*—Culture and uses of Okra' (Farmer's Bulletin No. 232, U. S. D. A.).
10. *Year Book of Agriculture*, 1937.—(United States Department of Agriculture, pp 207-232).

---

## ACIDITY OF INDIAN FRUITS.

By K. C. Batra, B.Sc., (Hons), Assoc. I. A. R. I., Chemists, G. G. Fruit Perserving Factory, Agra.

Batra (1) in his study on spoilage of fruit products has mentioned the role that the high acidity of fruits plays in producing hydrogen swells in jams and other canned products. The more acidic the fruits taken for making jam, the higher will be the acidity of the final product. While acidity on the finished goods is desirable to the extent which will inhibit the growth of micro-organisms, above a certain limit it has a deleterious effect. It so happens that the acid juices penetrate the porosities in the tin plating and attack the exposed iron, thus liberating hydrogen which ultimately results in the production of 'swells'. This attack on iron proceeds more vigorously in the presence of air, hence the necessity of having a high vacuum in the canned products. The food should be as free as possible from the entrained air, and the headspace should be kept as small as conditions allow. Though a little headspace is always a necessity, thus allowing the desired space to the liberated hydrogen produced as a result of corrosion of

the can, which invariably takes place, no matter what be the controlling factors and the precautions we take, it should, however, be not so much as to allow the possibility of the inclusion of air in the closed can. A headspace of $\frac{1}{8}''$ to $\frac{3}{16}''$ in the author's opinion is ideal for the canned foods.

Even though the prediction of the amount of corrosion from the acid content of the fruits is not possible, still with the poor quality of tinplate during the war-time having much of exposed iron as shown by the gelatin-ferricyanide test, it is certain that making jams from highly acidic fruits and thus keeping the acidity of the finished product very high is bound to result in troubles due to 'swells'. The question which naturally arises is as to how far we can control the above factor and select fruits of the least acidic nature.

During the course of a comparative analysis of Indian fruits, the author had also analysed most of these for acidity. The fruits selected were from different fruit producing areas. The question of the degree of maturity was borne in mind as fruit which is just ripe or a little under-ripe is used for jams. These naturally contained the maximum of pectin, so desirable for jam making. Table I gives the figures for acidity percentage expressed as equivalent anhydrous citric acid as compared with the figures obtained by workers in other countries. In order to have the same unit, all the results have been converted into anhydrous citric acid if these were not already given in that form.

*Table I.*

Acid of different fruits as anhydrous citric acid.

| Name of fruit. | Batra. | Chatfield and McLaughlin. | Hughes and Maunsell. | Vernon. L. S. Charley. |
|---|---|---|---|---|
| Apricots. (Stone free). | Min. 1.63<br>Max. 3.64<br>Av. 2.44 | ... | Min. .79<br>Max. 2.33<br>Av 1.50 | ... |
| Plums. (Stone free.) | Min. 2.45<br>Max. 3.90<br>Av. 3.13 | ... | Min. .16<br>Max. 2.47<br>Av. 1.38 | Min. .80<br>Max 1.50<br>Av. ... } Juice. |
| Peaches. | Min. .74<br>Max. 1.25<br>Av. .99 | Min. .33<br>Max. 1.43<br>Av. .61 | ... | ... |
| Apples. (Edible). | Min. .45<br>Max. 1.60<br>Av. .97 | ... | Min. .13<br>Max. 2.88<br>Av. .60 | Min. .20<br>Max. 1.20<br>Av. ... } Juice. |
| Pears. (Edible). | Min. .13<br>Max. .35<br>Av. .24 | ... | Min. .083<br>Max. .27<br>Av. .17 | ... |
| Lime Juice. | Min. 6.56<br>Max. 8.40<br>Av. 7.64 | Min. 4.2<br>Max. 7.2<br>Av. 5.90 | .. | Min. 6.0<br>Max. 7.70<br>Av. ... |

On going into the data carefully the following conclusions were arrived at:—

1. In all cases the average acidity of Indian fruits was higher than the corresponding acidity of fruits in other countries.

2. Even when we compare the acidity of a particular fruit as obtained by Batra with the corresponding acidity of the juice of the same fruit (V. L. S. Charley), the figures in the former case are higher though ordinarily the juice of a fruit should be more acid. This further enhances the importance of the first point.

3. The higher acidity of Indian fruits used in jam making is bound to be reflected in a higher acidity of the finished jam which is detrimental for the canned product and is liable to lead to spoilage due to 'swells'.

4. With the poor quality of tinplate used in can making, the action of a greater amount of acid is liable to accelerate corrosion, which otherwise may be negligible.

5. Taking the apricot, for instance, the average acidity of which is 2.44 per cent and taking the average figures, that is, 45 lbs. of fruit and 55 lbs. of sugar, we get the finished jam as having an acidity of 1.29 per cent. While calculating theoretically the acidity of the finished jam, we always take into consideration the fact that out of 100 lbs. of raw materials we get 80 to 85 lbs. of the finished product; and it is on basis of 85 lbs. that the figure of 1.29 per cent has been calculated.

If we examine the results of analysis of jams both made from Indian fruits and those imported from abroad, we are at once convinced as to the truth of the above findings.

*Table II.*

| Name of the product. | | Acidity found as anhydrous citric acid. | | Acidity calculated on basis of average data of Table 1. |
|---|---|---|---|---|
| Apricot jam (Indian) | 1.15<br>1.20<br>1.40<br>1.34<br>1.34 | Average | 1.286 | 1.29 |
| Apricot jam (foreign) | .64<br>.70<br>.72 | Average | .686 | .80 |
| Plum jam (Indian) | 1.34<br>1.34 | Average | 1.34 | 1.65 |
| Plum jam (foreign) | .54 | Average | .54 | .73 |
| Peach jam (Indian) | .54 | Average | .54 | .52 |
| Peach jam (foreign) | .48 | Average | .48 | .32 |
| Pear jam (Indian) | .32<br>.26<br>.20<br>.25 | Average | .26 | .13 |
| Pear jam (foreign) | ... | ... | | 0.88 |
| Apple jam (Indian) | .41<br>.26 | Average | .335 | .51 |
| Apple jam (foreign) | ... | ... | | .32 |

Allowing for the variations in the acidity of the fruits taken for jam manufacture, in the percentage of fruits and sometimes artificial acid added and finally in the amount of finished goods obtained, the results indicate the comparatively higher acidity of Indian jams. This problem assumes great significance in case of Indian apricot and plum jams when considered together with the poor quality of tinplate. The author's personal experience of an excessive amount of corrosion in case of the above jams verifies the above conclusions.

If we wish to decrease the acidity of the final product which is very necessary in case of apricot and plum jams, we can only do so by decreasing the percentage of fruits added, that is, instead of having 45 lbs. we may take only 30 lbs. or so. Now this procedure has a double disadvantage. Firstly, in the Agmark standard for jams a minimum of 45 lbs. fruit is required and we are necessarily to stick to it. Then by decreasing the fruit percentage we automatically increase the sugar percentage which makes the jams too sweet. Moreover, the basic idea of jams as providing the nutritive value of fruit pales into insignificance. The best remedy in this case resolves mainly into (1) choosing fruits of least acidic nature, which should not be difficult if the raw fruits are tested for acidity from time to time, and (2) invariably using lacquered cans. Of course danger due to 'swells' is considerably increased if the lacquering is not proper. In such a case the acid instead of acting on various exposed iron spots as in defective plain tinplate, concentrates its action on any little spot where the lacquering is missed. This is especially true of the joints at which the cans are soldered, which as a precautionary measure may be coated two or three times with lacquer to avoid this probable source of trouble.

## Summary

The high acidity of certain Indian fruits as compared to those in other countries is liable to produce more corrosion of cans, in case of apricot and plum jams in cans manufactured from poor quality of tinplate, available during the war. This can be controlled by using the least acidic type of fruits and lacquered cans in place of plain ones. Proper lacquering of the can is of course another factor which requires careful looking into.

The author feels greatly indebted to Mr. S. P. Agarwal, B.Sc., Assistant Laboratory Incharge, G. G. Laboratories, Agra, for a portion of the analytical work.

### References.


1. Batra, K. C. — Allahabad Farmer, January 1945.
2. Chatfield and McLaughlin. — U. S. Dept. Agr. Circ. No. 50 (1928).
3. Hughes and Maunsell. — Analyst 59,230 (1934).
4. Vernon L. S. Charley. — Food Trade Review, Vol. XIV, No. 6, (June 1944.)


---

The range of fruits that can be grown in India is unusually wide. All the ordinary European varieties can be grown in the high country in the North of India; while the tropical fruits can be grown in the plains and in Southern India.

—Sir John Russell.

# KEEP BEES FOR MORE AND BETTER FRUITS

By R. N. Muttoo, B. Sc., LL. B.

In the minds of most of us the honey bee is associated with the production of honey. In fact, the vast majority of people do not even know that the honey-bee has any other utility to mankind. It is, therefore, very necessary to make the facts, concerning the honey-bee, more widely known.

The honey-bee does produce honey, but in recent times, some scientists have been insisting that from the point of view of the benefits derived by the human race from the activities of the honey-bee, honey-production by the bee is merely secondary in importance. The real service which the honey-bee performs for the human race and for which it is of supreme importance to us is, according to these scientists, effective pollination of fruit and farm crops.

The knowledge of the inter-relation of insects and flowers and of the pollination activities of insects is of recent date even among scientists. From ancient times, we find the flower and the bee together in poetry and art; but the bee hovering round the flower was regarded as a tribute to the beauty and fragrance of the flower. But science, which seems to delight in destroying our most cherished fancies, stepped in to deprive the poet, the painter and the sculptor of this fanciful theme also. The bee was visiting the flowers not to admire their loveliness or fragrance but because the flowers gave the bee material food in the shape of nectar and pollen. And the flowers gave these presents to the bee because the activities of the bee resulted in the continuation of the race of flowers.

It was Christian Conrad Sprengel who first pointed out the true significance of insects' visits to flowers. This was at the close of the 18th Century, but his theory attracted but little attention at the time and it was left to Darwin to dig it out from obscurity. Thus it is from the time of Darwin that the matter has received any serious attention at the hands of scientists. And the further facts that of all the insects, the honey-bee is the most important in pollination, that several species of plants would become extinct but for the bee, that as a result of the activities of bees the fruit crop is improved both quantitatively and qualitatively have been found by the scientists only yesterday. Organised practical application of these findings has yet to come. The writer is not aware of any organised attempt to utilise the honey-bee for the production of more abundant crops except the one made in Russia where bees were kept in fields with the avowed object of producing more seed, honey-production being only a secondary aim.

It is the object of the writer to draw the attention of scientific workers to this important aspect of increased food production through the agency of bees. It is only in the last decade that they found in the U. S. A. that 'for every dollar worth of honey which the bee produces, it produces 14 dollars worth of extra fruit' (Prof. Paddock). The writer has himself observed the beneficial effect of bees on apples, strawberries and other fruit crops and he has been keeping bees for pollinating his own fruit orchard.

Thanks to the work of scientists, countries like the U. S. A. and England are increasingly adopting the practice of keeping bees in fruit orchards for the production of more and better fruit. It is time that this practice was adopted by orchardists in India also.

It is well-known that many fruit varieties are self-sterile. To name some of the self-sterile varieties of apples, there are Delicious, Baldwin, Grimes Golden, Stayman, Winesap. The sweet varieties of the Cherry are all self-sterile. Similarly 50 per cent of the varieties of the pear and the plum are self-sterile. While all varieties benefit through the activities of bees, the self-sterile varieties are specially dependent upon insects for effective pollination and fruit-setting.

Among insects, the honey-bee is of special importance in pollination as will be seen from the following statistical data collected by workers in the west: It was found that out of every 100 visits to a flower by insects, 88 per cent visitors were honey-bees, 6 per cent were bumble bees and other wild bees, and 6 per cent were other insects.

The bee is in other ways most suited for pollination work. Its size, its hairy body, its habit of visiting the same species of flowers in any one trip and its dependence on pollen for the rearing of its own brood which necessitates repeated visits to flowers, all these combine to make the honey-bee the most useful pollinating insect. And then there is the fact that if man is to take the help of insect friends for pollinating purposes, it is difficult to think of any other insect which can be so easily controlled and which is at the same time so prolific. Again, the keeping of bees is by itself an economic proposition on account of the honey which the bees produce.

In colder climates, some fruits bloom at a time of the year when hardly any insects are available. The plum, the apricot, the almond, etc., bloom very early in spring when the insect population is very low. The honey-bee is a remarkable insect in that it survives the cold weather through its habit of "clustering" and thus this is the only insect available for pollination, in early spring, in any number.

It is a well-known fact that during the receptive condition of many fruit-blossom stigmas, the stigma is specially susceptible to frost and climatic changes. If pollination is not effected quickly, owing to the absence of enough insects at this stage, much fruit may be lost through inclement weather injuring the pistils before pollination is effected. After pollination, the pistils are not so susceptible to climatic variations. Thus quick and early pollination is one way of ensuring a good crop-set and for this bees are very necessary.

---

A special feature of large scale fruit growing, and one which makes it very attractive to men who like the organization of an estate and the possibility of doing well, is that it requires for full success and development in each important fruit growing centre of certain subsidiary industries. The most important of these is the preserving of fruit and vegetables by various means and the making of fruit products, so that unmarketed fruit can be converted into some marketable form and potential waste material can be used to good purpose.

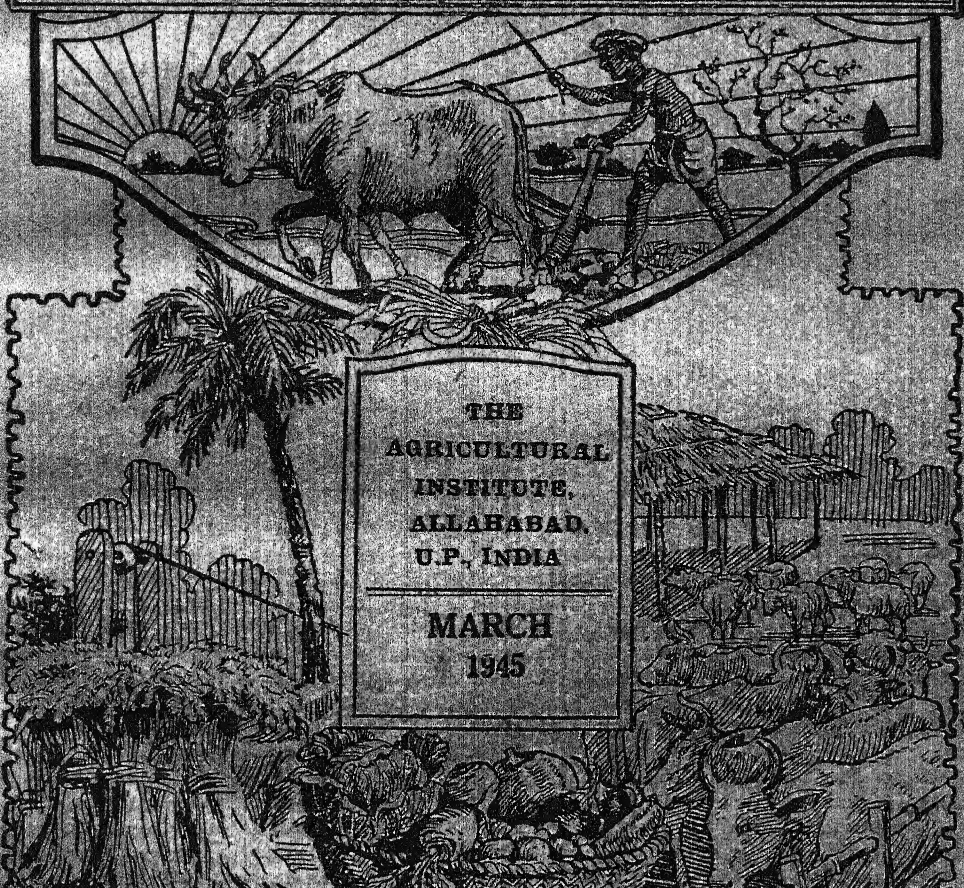
—Sir John Russell.

Registered No. A-925

VOL. XIX] [No. 2

# THE ALLAHABAD FARMER

A bi-monthly Journal
OF
Agriculture and Rural Life




"Land is the great reservier of our strength as a Nation. It is the foundation upon which an expanding economy can be built. Like the legendary giant, Antaeus, whose strength was renewed every time he touched the earth, so also our strength must become from the fullest use of all the land.

—Raphael Zon."

# THE ALLAHABAD FARMER

## A BI-MONTHLY JOURNAL OF AGRICULTURE AND RURAL LIFE



The ALLAHABAD FARMER is now approved by the Directors of Public Instruction in the United Provinces, Bengal, Central Provinces, Sind, Assam, Bihar and Orissa, the Rural Reconstruction Commissioner, Punjab, and by the Director of the Institute of Plant Industry, Indore, and Agricultural Adviser to Rajputana and Central India States, for use in all schools under their jurisdiction.

### Subscription Rates

Annual subscription : India, Rs. 3 ; England, 4 shillings ; U.S.A., 1 dollar. Single copies, 10 annas ; over five years old, 12 annas. Copies which are not received by subscribers will be supplied free of cost within six months of the month of issue. Thereafter single copy prices will be charged.

Unused portions of subscriptions cannot be refunded.

### Advertising Rates

| | Rs. | a. | p. |
|---|---|---|---|
| One full page of six numbers .. .. .. | 35 | 0 | 0 |
| One single full page .. .. .. | 7 | 0 | 0 |
| One half page of six numbers .. .. .. | 20 | 0 | 0 |
| One single half page .. .. .. | 4 | 0 | 0 |
| Page 2 or 3 of cover for six numbers .. .. | 50 | 0 | 0 |
| Page 4 of cover for six numbers .. .. .. | 70 | 0 | 0 |

### Contributions

The ALLAHABAD FARMER is published in the first week of each alternate month commencing with the month of January. Contributors are requested to send in their articles at least one month prior to the next prospective date of publication.

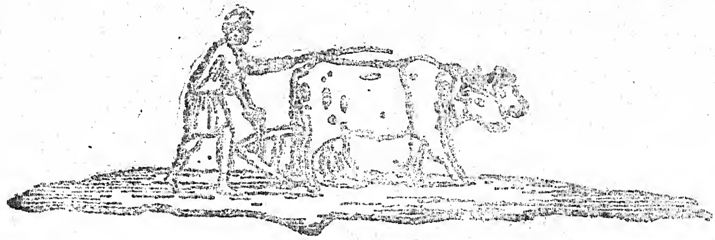
Contributors will receive 15 reprints of the article published and additional copies at cost.


*Publisher*—The Allahabad Agricultural Institute, Allahabad, U.P. (American Presbyterian Mission).

*Printer*—The Mission Press, Allahabad, U.P.


## CONTENTS

# THE ALLAHABAD FARMER



VOL. XIX] MARCH, 1945 [ No. 2


## Editorials

### The New Principal of the Allahabad Agricultural Institute.

We take this opportunity to introduce to our readers Dr. J. L. Goheen the new Principal of the Allahabad Agricultural Institute. Dr. Goheen is not new to this country as he was born in the Bombay Presidency, and worked there, after his training in the United States of America, for a period of about 30 years. While in the Bombay Presidency, he started the Industrial School at Sangli and also became its Principal. He comes here to us in the United Provinces, therefore, with experience of industrial development, through education in other parts of India.

Somewhere in this issue the readers will find an article written by him which speaks for itself. The article shows the vision which he has of the place of the Institute as an agricultural institution in the future development of this country.

### An agricultural economist and the Social problems of India :

"......... It is now admitted on all hands that planning is the immediate need of our country, if chronic poverty is to be avoided. But then, we do not want the plan to be a half-hearted and experimental measure. What we need is a comprehensive plan which would first go to the foundations of our economic and social structure, analyse the root causes of our various evils and then provide an adequate organisation for their removal. Any plan which overlooks these essentials would not have its basis in 'social reality', and would, therefore, prove sterile. There are several other aspects of the problem..................... There is the question of population plenning, for instance, or the question of financial and trade policy in its bearings on agriculture, or, again the problem of extending and rehabilitating the co-operative movement. Every one of these problems has a technical aspect, an administrative aspect and a social aspect, which must be taken into account. A satisfactory solution of these will demand all our energies, all the good will and co-operation we can muster for this noble, idealistic work."—SIR MANILAL B. NANAVATI.

# TOWARDS A HAPPIER DAY IN RURAL INDIA.

By Dr. J. L. Goheen, Principal,

*Allahabad Agricultural Institute.*

In the process of becoming re-oriented, after an absence of a good many months from India, it is refreshing and encouraging to find that both in the central and provincial governments there are great plans under way for the removal of poverty, mal-nutrition, disease, illiteracy, indebtedness and the other numerous handicaps and disabilities from which the great bulk of the people of India are suffering. This planning has in mind a comprehensive and constructive programme of advance.

In this province I find that the Post-War Reconstruction Board has done some excellent spade work in the way of planning and devising for the future which, when completed and prosecuted to a successful conclusion, augers well for those who will live in the India that is to be. The determination to effect change for the better is part of the world-wide spirit now prevalent that man must live happily, freely and abundantly.

It is not at all surprising that the Agricultural colleges in India and elsewhere, should be at the forefront in these moves which look toward a better future in all that pertains to the economic, physical, social, and even spiritual welfare of the people of rural India. In western countries such colleges have been playing a role of this nature for well-nigh two generations; whereas in India it may be more nearly accurate to say that only from one generation, or even less, have the agricultural colleges been so functioning. In any case it is their ministry to help the great agrarian multitudes of India to attain to a more satisfactory standard of life.

It may not be amiss to record briefly some of the great advances that agricultural science and research have been accomplishing in recent years. For instance, the geneticist to-day is becoming a sort of designer and architect of plants and of animals. Within comparatively few years it well may be that "domestic plants and animals will have been developed to fit every known local environment of man." Soil science and soil conservation are making significant strides so that not only is soil fertility (in spite of the present heavy war production) maintained but it is also being increased. Due to electrification drudgery in the farm home in western countries is rapidly disappearing. Women and children are enjoying the benefits of modern education, that is, education suited to rural living, and they are having opportunities also to enjoy culture.

Progress in the control of plant and animal diseases, and that of pests, is just as remarkable. There are some outstanding examples of this especially in connection with live-stock on the farm of this Institute. What a happy day for the future of rural India when an insectitude such as D.D.T. will become available for the removal of many of the discomforts of the home and even from some of its diseases such as malaria, plague, etc. Engineering on the farm through the employment of suitably adapted power and machinery, not only removes untold drudgery but results in greater efficiency through the timeliness of operations.

So too in the fields of co-operative marketing and numerous other co-operative organizations, both credit and non-credit, efficient farm management, land tenure enactments, rural education and recreation, old and young of both sexes are living happier, healthier and more abundant lives. Since farming is primarily a family occupation it is only fitting that such results should be achieved for the benefit of all those who are engaged in it.

What I have just said applies more accurately, I fear, to conditions in western countries and not nearly as fully as yet as it should to India. However, there is no question that there has been increased production of agricultural products in India, due to the 'grow more food' campaign here, and certainly agricultural production in England, Canada, the United States, and certain countries in the Southern Hemisphere, has exceeded records of former production by large margins. The agricultural colleges of India through the splendid work of their staffs and graduates have been doing very significant work in this country too.

In western countries, and more especially in Canada and the United States, the agricultural extension service has been developed to a very remarkable degree within the present generation. I can well recall my own experience as a growing boy who spent his summer holidays on the farm when there was no such extension service in existence. In fact, in those days agricultural colleges and experiment stations were looked upon with suspicion and even distrust by farmers. They criticised severely governmental expenditure of funds for the support of these colleges and stations.

And then, in 1914, there began the development of this extension service. The term "extension" as used today applies to the passing on of information gained through scientific research and the practical application of the same in the agricultural colleges and experiment stations, to the farmer and his family. It is a form of continuing education carried on by highly trained specialists in Agriculture and Home Economics who have been chosen because of their qualifications of understanding leadership. They are the liaison officers between the institutions mentioned and the farmer and his home because they not only take out new information backed up by inspiration, but they bring back interrogation from the farm and the home often accompanied by perspiration.

Since this extension service is chiefly an educational process it is to be expected that scientific method and research when applied to the educational field can contribute here as much as when applied to sciences like biology, or practical fields like animal husbandry. I take the liberty of quoting here from Dr. M. L. Wilson who is the present Director of the Extension Service of the U. S. Dept. of Agriculture. While addressing an important conference on extension work in Washington, in September, 1944, he said:

"The basic social sciences, which bear the same relation to the educational process as chemistry and physiology bear to farm crops and animals, consist first of the sciences dealing with culture and behaviour and interaction of individuals and groups within their culture. Involved are the various special fields in psychology, in cultural anthropology, and in sociology. Though we, by no means, know all that is to be learned about the processes through which ideas change, we know something of the process. What we do know serves as a basis for scientific educational methods in extension work.

"Scientific workers in this field are in general agreement that, with the present state of knowledge of culture and cultural development, one culture cannot be forced upon another. Development has to take place from within and cannot be forced from without.

"This point of view was beginning to influence social scientists in agriculture before the outbreak of the war. The International Congress of Agricultural Economics, an international, non-governmental organization, has done much toward bringing about common understandings and a world view with reference to the social and economic forces in world agriculture. At the fifth and last International Congress, held at Macdonald College in Canada in 1938, the founder and president, Mr. Leonard K. Elmhirst, in his opening address said:—

'Social anthropologists and others have begun to point out how wide a variety of social patterns exists in the world and how all these patterns tend to remain stable so long as their basic economic structure remains undisturbed. If this economic base is too suddenly or too drastically upset, the social pattern suffers all kinds of psychological stresses and strains because it still rests upon so many unchartered instincts and tabus, unconscious and subconscious emotions, which delay and even prevent that free interplay of feeling and intellect that marks the study of economic forces and patterns. The sudden economic changes of the post-war era have left behind a legacy of psycho-social damage which it may take years of research and education to repair. In the main, in rural areas we are today dealing with such a condition since age-long unquestioned patterns of village and rural society are having to face the coming of the machine and pull of the great city.'

"The great cultures of mankind in Asia and Africa, as they evolve with relation to scientific agriculture, must develop, their extension work in ways quite indigenous with them. We in the United States Dept. of Agriculture, and in our State land-grant colleges, would be the first to agree that our form of organization of extension work and our methods are the product of our culture. The first lesson to be learned about them is just that. Therefore, in extending scientific knowledge to farmers through the world, each culture, each nation, and each group will have to develop its own forms of organization and methods out of its own cultural background. We believe, however, that basic principles apply everywhere, and that studies and observations of the development of extension practices and methods throughout the world will be of value and stimulating to all people."

Those of us who have had a good many years' experience with rural folk in India know something of the truth of that statement. We do know that one of the basic problems in extension work in this country is, that the worker be willing to put himself on the level of the backward villager so that he may see through his eyes, understand the workings of his mind, know his culture, and what is most important, show a sympathetic spirit such as will win his confidence. For it is absolutely necessary that that backward villager and his family shall want to improve their lot and be willing to co-operate whole-heartedly with the worker to that end. Only so does it become likely that the urge for better living becomes dominant, and the demand for it comes from within. When that happens, what takes place is something that becomes rooted and grounded in the life of the village.

Again, it is most desirable that certain features of rural life and culture be conserved and encouraged. There is, for example, the love of the soil, the simplicity of life, the love of music, drama and of certain simple types of sport and folk dancing. Then too, there are a good many forms of natural co-operation which ought to be studied and cultivated so that more complex forms may be successfully introduced.

The development of other forms of livelihood, in addition to those the farmer now employs, in order that there be a decided reduction in the excessive pressure of the population on the soil; the need to inculcate habits of thrifty living, and the very best use of all the resources at his command, including those of head, hand and heart—all these and similar important problems come within the scope of the extension service in India. And in the consideration of these problems the question of the goals to be attained, the best methods and techniques to be employed, and the qualifications, selection and training of workers, must recieve primary consideration.

Through the faith, vision, courage, enthusiasm, organizing and propagandizing ability of Dr. and Mrs. Higginbottom, the Allahabad Agricultural

Institute has achieved for itself a position of distinction and recognition, not only in this province, but in the rest of India, and outside as well. The several departments in the mens' side of the Institute are in a flourishing condition and the applications for admittance are exceeding the ability to admit by a large margin because of lack of hostel space. The foundations have been broadly and soundly laid. Graduates of the Institute are serving well their country and their Alma Mater in many parts of India. The plans for Expansion will be faithfully carried out, and it is certain that the Institute will continue to grow on these foundations. God grant that its service may be blessed in the future as it has been in the past!

The foundations of the Home Economics Department have been much more recently laid, but here too, through the consecrated energy and enthusiasm of Mrs. Higginbottom, this department is now attaining young womanhood. It is one of the most important of all of the services which this Institute can and does render. How greatly the homes of India may profit by such training as is given to young women in the courses offered (and to be further developed) is not difficult to imagine. Let me assure Mrs. Higginbottom on behalf of the staff and well-wishers of the Institute that everything will be done to conserve and develop the best interests of this department. And let me assure both Dr. and Mrs. Higginbottom that the Allahabad Agricultural Institute will hold in respect and reverance for aye the memory of the great service they have rendered to India.

And now for the future? As a new Era is about to begin for this Institute, and as we look forward to the challenge of the days ahead, we contemplate the development of an extension service, together with suitable training in rural sociology, group psychology and cultural anthropology for the preparation of these liaison officers who are to take out good news in agriculture and home economics and bring back sometimes good, often-times perplexing, news from the people whom they are serving. There is no question but that the remarkable advance made in rural life and in agricultural production in Canada and the U. S. A. is largely due to the fact of this co-operative extension service between the farm and its home, and the sources of expert knowledge the agricultural college research station.

In most agricultural colleges the world over one finds a remarkable spirit of democracy and of consecration to work. The Allahabad Agricultural Institute has been blessed with this spirit, and I think that one can safely say there is an additional factor in the atmosphere here which is notable, namely, the sense of missions, or in other words of responsibility to one's country and one's people. Let me assure all concerned that now is the time to capitalize on this spirit, especially as there will be so many demobilized soldiers in addition to the regular students who are coming here to be trained in scientific agriculture who will return to their villages and be able to increase their yields. This sense of mission ought to be characteristic of a missionary institution. I hope it becomes more and more characteristic not only of this institution, but of all institutions in this great land of India. So, as a missionary institution we feel that it is our very special responsibility to reach out even into the most remote and most difficult places in order to help save the "forgotten man and his family". We have a vision of a very different India fifty years from now, but it is only as the weakest link, namely, the most illiterate as well as the most literate, is reached and strengthened that this land will become truly happy, free and have abundant life. And we recall with gratitude the words of Jesus Christ, our Master, when he said, "I came that they might have life, and that they might have it more abundantly."

# THE U. P. MILITARY POULTRY DEVELOPMENT AND MARKETING SCHEME.

By

JOHN A. MANAWWAR,

*Provincial Marketing Officer, U. P.*

## INTRODUCTORY.

In the year 1943 a considerable fall in the number of eggs graded at some of the Agmark Egg Grading Stations and the prevalence of abnormally high prices of poultry, and eggs in the important consuming centres of the province led the U.P. Marketing Staff to conduct a rapid survey with a view to studying the actual position of the poultry industry in the province. A number of important consuming, assembling and producing centres were visited and various agencies in the chain of marketing of poultry and eggs were interviewed, for the collection of relevant information in respect of the scarcity of these commodities and high prices. The investigations showed beyond the shadow of a doubt that the causes for the scarcity and high prices were: 1. a great increase in the demand—both civil and military, and 2. an alarming decrease in the production of poultry and eggs all over the province.

The increase in the civil demand was not as great as the increase in the military demand. The military demand had increased many times and not only that but it was anticipated that with progress of the war it will increase much more.

The requirements of some of the cantonments as compared to pre-war days had gone in some cases as much as 100 times. The military contractors failed to supply poultry and eggs in a number of places on the contracted prices. The prices rose 50 to 100 per cent and in many cases still higher and the purchases had to be made from the civil markets and even then the military demand could not be met.

The situation was further aggravated by the conduct of the military contractors. They resorted to indiscriminate purchase of female and male birds alike The good laying female birds were purchased at high prices for table purposes The country side, in the province, was being denuded of good poultry and it was apprehended that a stage would soon be reached when the province would be faced with total depletion of its poultry.

In order to avert the crisis it was, therefore, imperative that a scheme should be launched which would not only conserve the good poultry of the province but will take up increased production and develpment on the one hand and meet the abnormal military demand on the other. The increased civil demand was also not lost sight of, but it was not to be taken up till effective measures had been adopted for meeting the military demand which was to have priority on account of the war.

### Initiation of the U. P. Military Poultry Development and Marketing Scheme and Agreement with the Central Command.

In a series of meetings held between the representatives of the U. P. Government and of the Central Command at Lucknow, the U. P. Military Poultry Development and Marketing Scheme was carefully scrutinised and necessary changes made. The scheme was finally sanctioned on February 1, 1944, in a meeting held at the headquarters of the Central Command, Agra, wherein

representatives of the U. P. Government, and of the Central Command were present under the chairmanship of Major General, Incharge, Administration, Central Command, Agra. The scheme was to run under the general supervision and control of the Director of Animal Husbandry, U. P., Lucknow and under the direct charge of the Provincial Marketing Officer, United Provinces, Lucknow. According to the terms of the Agreement the scheme was to run for 3 years on a no profit no loss basis. The U. P. Government was to meet the recurring and non-recurring expenditure of the Government Central Poultry Farm, Dilkusha, Lucknow and the non-recurring expenditure of the scheme, while the army was to bear all the recurring charges, *viz.*, Rs 1,38,000 for the first year, Rs. 1,80,000 in the second and Rs. 1,75,000 in the third year. The U. P. Government was to hand over the entire produce of the Scheme with the following minima :—

20 per cent. of the 1943 fowls requirements in the first year.

30 per cent. of the 1943 fowls requirements in the 2nd year.

50 per cent. of the 1943 fowls requirements in the 3rd year.

75,000 eggs weekly on a graduated scale.

The Central Command was also to place an Imprest Advance of Rs. 1,00,000 at the disposal of the U. P. Government for day to day financing of the scheme which was to be recouped weekly.

**Aims and Objects of the Scheme.**

1. *To inceease the production of poultry and eggs as fast as possible to meet the immediate abnormal military and civil demands* :—The first step in this connection was to take over the poultry farm at Dilkusha, Lucknow, from the U. P. Poultry Association which was a Government aided body. In the executive committee, of the U. P. Poultry Association held in the month of October, 1943, the Director of Veterinary Services, the President of the Executive Committee, explained the object of the scheme and requested the Members present to agree to the transfer of the farm to the U. P. Government at least for the duration of the war and to this the members gave their consent. From the 1st January, 1944, the poultry farm at Lucknow, now called the Government Central Poultry Farm, Lucknow, was taken over by the U. P. Government. This farm became a big commercial hatchery for the large scale production of eggs and birds for stocking the 10 branch and subsidiary farms, which were opened subsequently in the scheme. The farm was considerably extended for the rearing of these birds and by the end of March, 1944, about 4,000 chicks were hatched at this farm.

The new scheme was to function in two concentrated areas where there were good prospects for poultry development. These two areas were called the Moradabad Zone and the Fyzabad Zone. Each zone was to have one Branch Farm consisting of 10 pens of birds and 4 subsidiary farms each having 5 pens of birds. A pen is made up of 10-12 hens and 2 cocks. The following centres were selected in these 2 zones for these farms :

(1) Moradabad Zone: Branch Farm at Moradabad and subsidiary farms at Amroha, Nagina, Bilari and Sambhal and (2) Fyzabad Zone : Branch Farm at Fyzabad and subsidiary farms at Partabgarh, Sultanpur, Shahganj and Rudauli.

It took some months to establish these farms on account of the delay in the procurement of constructional materials. All these farms have now been established and they are commercial hatcheries for the propagation of improved birds and also serve the purpose of ocular demonstrations.

On account of the poor economic condition of the poultry keepers in the rural areas, experience has shown that by the distribution of improved eggs

there is considerable wastage and, therefore, the general policy laid down in the scheme is to hatch and rear chicks 3 to 4 months and then distribute them to the village poultry keepers. These birds are distributed on exchange basis, *i.e.*, one improved bird in exchange with a country bird preferably a country cock.

The increased production is also done by distribution of improved eggs when they are a surplus or when it is not possible to hatch them at the Central, Branch or Subsidiary Farms.

Another step taken for increased production is that the Poultry Staff is to carry on extensive propaganda and publicity for the hatching of the country birds as well. This has been successful in most of the centres and price factor has also given great impetus to increased production in this manner.

Gazette Notification No. 632/XIII-D-58-44, dated May 13, 1944 from the Animal Husbandry Department, U.P., prohibits more than 25 per cent female birds to be transported in any consignment despatched by rail, road or river. The object of this notification was to conserve the stock of female birds in the rural areas for increased egg production.

The U.P. Government also promulgated a Poultry Control Movement Order (*vide* Notification No. 545/XII-D-58-44), published in the Government Gazette of the United Provinces dated May 20, 1944, banning the export of poultry and eggs from the province without a permit. The Order is reproduced below :

| | |
|---|---|
| 1. Fyzabad<br>2. Jaunpur<br>3. Barabanki<br>4. Sultanpur<br>5. Partabgarh | Senior Poultry Inspector, Fyzabad. |
| 6. Lucknow<br>7. Rae Bareli<br>8. Bahraich<br>9. Gonda<br>10. Badaun | Provincial Marketing Officer, United Provinces, Lucknow. |
| 11. Moradabad<br>12. Bijnor | Senior Poultry Inspector, Moradabad. |

"In exercise of the powers conferred by rule 81 (2) (a) of the Defence of India Rules, the Governor of the United Provinces is pleased to order that no person other than the office noted against each of the 12 marginally mentioned districts shall export poultry from any place in these districts to any place outside them whether by rail, road, river or any other means. Poultry is defined as including fowls, chicken, ducks, geeses, and turkeys.

Possibilities for immunizing the birds against the Ranikhet disease, which is a "bug-bear" of the poultry industry, have also been explored. The entire stock of the Government Central Poultry Farms Lucknow (about 3,000) which has been distributed to the Branch and Subsidiary Farm and the development villages was vaccinated. It is the biggest experiment of its kind ever undertaken and the results are keenly awaited.

In order to meet the demand for trained personnel in poultry keeping on modern lines, a three months' practical course has been started at the Government Central Poultry Farm, Dilkusha, Lucknow. Besides, a few honorary workers are engaged at the Central, Branch and Subsidiary farms as apprentices.

To avoid losses due to staleness during hot weather, defertilization experiments have been conducted by the Central Command, at Agra. Three defertilizing apparatus have been supplied by the Central Command, Agra, for trial. By defertilization eggs can be kept for 6 to 7 days in the hotest weather without going bad. These defertilizing apparatuses will be tried at the Government Central Poultry and Egg Godown, Lucknow, and at Sultanpur. Sultanpur is the biggest collecting centre giving 6,000 to 7,000 eggs per day and the transport from Sultanpur to Lucknow on account of transhipment at Fyzabad takes longer time than other centres and eggs have to travel through the day.

It is also proposed to take up pickling of eggs and have a specially designed truck for the collection and transhipment of eggs during the hot weather.

2. *To organize collection and marketing of Poultry and eggs to meet the Military demand in Lucknow and Jhansi Military areas* :—For the organisation of collection and marketing of poultry and eggs to meet the Military demand, 12 districts out of 48 districts of the province were allotted to the scheme. Out of 12 districts 7 fall in the 2 zones, *viz.*, Moradabad Zone consisting of Moradabad and Bijnor, and Fyzabad zone consisting of Fyzabad, Sultanpur, Partabgarh, Barabanki and Jaunpur.

The 5 districts Rae Bareli, Badaun, Bahraich, Gonda and Lucknow were outside these zones where on account of shortage of improved poultry and eggs no development work could be carried on and only existing supplies were collected and handed over to the military department. On account of heavy civil demand the district of Lucknow was left free and no supplies of eggs and fowls were taken for the military from the Lucknow district.

All these 12 districts allotted to the scheme are closed districts. The movement within a district for meeting the local demand is free, but no eggs or fowls can be exported from these districts, even within the Province, without the recommendation of the Provincial Marketing Officer, United Provinces, Lucknow, an officer incharge of the scheme, or of his representative. The offtakes of poultry and eggs are taken by the Poultry Staff in the scheme. Round about a poultry development centre 4 big villages or 4 groups of villages are selected where the offtakes are purchased directly by the supervisors through the *kamdars* at -/1/-, -/1/3 and -/1/6 per egg and fowls at Re. 1/- per lb. live-weight. In these very villages the improvement work of poultry is concentrated and, therefore, efforts are made to purchase all offtakes of poultry and eggs of these villages at these prices. These prices are gradewise which are :—

| | | | | |
|---|---|---|---|---|
| 1¾ oz. or above | ... | 0 | 1 | 6 |
| 1½ oz. to 1¾ oz. | ... | 0 | 1 | 3 |
| Below 1½ oz. | ... | 0 | 1 | 0 |

These grade-wise prices prove a stimulus to the village poultry keepers for taking to improved poultry.

Outside these villages, where the Poultry Staff cannot reach, areas are allocated to local egg collectors who are allowed to collect and bring eggs and poultry to the purchasing centres. These local egg collectors purchase eggs at a flat rate of -/1/- per egg and sell to the purchasing centre at -/1/-, -/1/3, and -/1/6 the difference being their profit. Fowls are purchased at the Centre at Re. 1/- per lb. (live-weight) while the contractors are allowed to purchase at -/14/- to -/15/- per lb. (live-weight) and sell to the centre at Re. 1/- (live-weight).

From the above, it is evident that efforts have been made not to oust any body from the egg and poultry trade but to control their activities in in such a manner as would ensure a fair price to the producers. A few egg collectors or contractors who are ousted are employed as *kamdars*—each centre having 6 *kamdars* besides poultry attendants, etc. Thus no one in the egg trade has been deprived of his livelihood.

All the eggs and poultry purchased at the centres are assembled at the Fyzabad and Moradabad sub-depots and Government Central Poultry and Egg Godown, Chandapur House, Latouche Road, Lucknow, from where they are handed over to the Military after testing and grading. The Fyzabad and Moradabad sub-depots only supply small quantities while the main supply centre is the Government Central Poultry and Egg Godown, Chandapur House, Latouche Road, Lucknow.

From Lucknow, supplies are made by the Military department to the Lucknow and Jhansi areas and also to Nainital, Lansdowne and Dehradun, etc., if there is a surplus.

The price paid by the military department for eggs and fowls have been gradually reduced from quater to quarter. To start with these were :—

| *Eggs* : | | Rs. | a. | p. | |
|---|---|---|---|---|---|
| Grade I. | ... | 1 | 14 | 0 | per dozen |
| Grade II. | ... | 1 | 11 | 0 | " |
| Grade III. | ... | 1 | 6 | 0 | " |

Fowls at Re. 1-8-0 per lb. live-weight.

At present these are as follows :—

| *Eggs* : | | Rs. | a. | p. | |
|---|---|---|---|---|---|
| Grade I. | ... | 1 | 10 | 0 | per dozen |
| Grade II. | ... | 1 | 8 | 0 | " |
| Grade III. | ... | 1 | 8 | 0 | " |

Fowls, at Re. 1-6-0 per lb., live-weight.

These prices are Ex-godown or delivered at the Military Hospitals.

3. *To carry on development of poultry scientifically and systematically as a long range policy for the post-war period by improving the local breed of poultry and size of eggs* :—In formulating the scheme the long range policy of post-war days has not been lost sight of. The two zones where the development work is concentrated are centrally situated to cater for the important consuming centres in the United Provinces and Delhi. The Fyzabad zone consisting of the districts of Fyzabad, Partabgarh, Sultanpur, Barabanki and Jaunpur can easily cater for the important consuming centres such as Lucknow, Allahabad, Benares and Cawnpore and the Moradabad zone consisting of the districts of Moradabad and Bijnor can easily cater for Moradabad, Bareilly and Delhi. Even in the post-war days collection and marketing from these areas will be an economic proposition.

During the present time "quantity" is a slogan, but in the post-war days "quality" will be in demand. The policy followed in the scheme is to concentrate all development work in selected villages round about a poultry farm. The improvement is being carried out in two ways :—1. By grading up the present indigenous stock and 2. By the introduction of pure bred improved breeds both male and female village-wise.

All the poultry keepers of development villages are persuaded to become "Registered Poultry Keepers" on payment of Re. 0-4-0 fee per annum. There are certain conditions laid down for the registration of poultry keepers—the chief being that they will not keep any country or cross bred cocks. In exchange for these country and cross bred cocks or on payment of Rs. 3 they are given pure bred cocks of improved breeds. In one village only one breed is distributed. Besides, they are given pure bred both male and female birds and eggs for hatching at a concessional price of Re. 0-2-0 each. The full price of pure bred birds at the Government Central Poultry Farm, Dilkusha, Lucknow, ranges from Rs. 12 to Rs. 15 each and, for eggs Rs. 12 per setting of 15 eggs. The difference in price is being subsidised by the Milatary department in the scheme.

Thus it will be seen that great care has been taken to provide for the permanent improvement of the poultry industry of the province in the scheme. Not only large sized improved eggs will be available at competitive prices for important consuming centres of the province and Delhi but the Poultry Industry also will be built up in the development villages selected in the scheme.

As work progresses, it is proposed to close these villages to the trade so that outside birds may not enter and crossing will be avoided.

Since some of the improved breeds do not become broody, the difficulty of hatching eggs of village poultry keepers can be got over by arranging for their incubation at the poultry centres where two to six incubators have been provided for.

It is also proposed to study the Chinese method of hatching in paddy straw which is reported to be successful on the farms of the 14th Army. If the reports are correct, it may be possible to introduce this method with some modifications in the villages.

## Progress of the Scheme.

The supplies of fowls and eggs made through the scheme to the Military department during the last three quarters (April to December, 1944) and the income earned are given below :—

1st Quarters (*April to June*, 1944).

| | | | | |
|---|---|---|---|---|
| *Eggs* :— | I Grade. | 58,059 | *Fowls and other birds* | |
| | II Grade. | 2,86,053 | Number | 19,407 |
| | III Grade. | 2,37,889 | Poundage | 58,900.198 |
| | Total ... | 5,82,001 | | |

| | | |
|---|---|---|
| Gross receipts | ... | Rs. 1,67,323-12-0. |
| Purchase price | ... | Rs. 1,04,809-7-3. |
| Net Receipt | ... | Rs. 62,514-4-9. |

2nd Quarter (*July to September*, 1944).

| | | | | |
|---|---|---|---|---|
| *Eggs* :— I Grade | ... 87,293 | *Fowls and other birds* : | | |
| II „ | ... 4,65,246 | Number | ... | |
| III „ | ... 3,79,214 | Poundage | ... | ... 12994.245 |
| Total ... | 9,31,753 | | | |

| | | |
|---|---|---|
| Gross Receipts | ... | Rs. 3,00,413-1-0 |
| Purchase price | ... | „ 2,11,238-2-6 |
| Net receipts | ... | „ 89,174-14-6 |

3rd Quarter (*October to December*, 1944.)

| | | | | |
|---|---|---|---|---|
| *Eggs* :— I Grade | ... 1,00,964 | *Fowls and others lirds* : | | |
| II „ | ... 7,95,827 | Number | ... ... | 42,262 |
| III „ | ... 4,17,560 | Poundage | ... ... | 1,19 599.49 |
| Total ... | 13,14,311 | | | |

| | | |
|---|---|---|
| Grass receipts | ... | Rs. 3,51,794-10-10 |
| Purchase price | ... | „ 2,72,997-14 6 |
| Net receipts | ... | „ 2,78,796-12-4 |

*Total Supplies and net income for three Quarters (April to December, 1944).*

| Supplies. | | Net Income | |
|---|---|---|---|
| Eggs ... ... | 28,27,075 | 1st Quarter ... | Rs. 62,514-4-9 |
| Fowls and other Birds ... | 1,06,402 | 2nd „ ... ... | „ 89,174-14-6 |
| Poundage ... ... | 2,98,693,933 | 3rd „ ... ... | „ 78,796-12-4 |
| | | Total net receipts ... | Rs. 2,30,485-15-7 |

Besides the above 328 ducks, geese and turkeys (receipts Rs. 6,312-11) were also supplied at the special request of the Deputy Assistant Directors of Local Purchase, Lucknow and Bareilly regions, for the Christmas Fare.

From the above statement, it is evident that the scheme has been a great success. The total recurring expenditure for the whole year is Rs. 1,38,000 while the total net receipts accruing from the scheme for 9 months are Rs. 2,30,485-15-7, *i.e.*, there is already a net profit Rs. 92,485-15-7.

Out of a total recurring expenditure of Rs. 1,38,000 it is also anticipated that there will be some saving at the end of the year.

## Extension of the Scheme.

At the request of the Central Command the Second Phase of the extension of the scheme comes into effect from the 1st April, 1945. This extension will meet the major portion of the demand of the Bareilly region. Four more districts, *viz.*, Shahjahanpur, Hardoi, Lakhimpur-kheri and Azamgarh are being added to the scheme. In place of Lucknow which has become a semi-controlled district the district of Basti has been substituted. 7 more Branch Poultry Farms—5 in new districts and 4 in such old districts where they were not provided originally are being established. With the extension, it is proposed to give to the military department the total supplies of 1,25,000 eggs and 7,000 fowls weekly.

## Scheme for Meeting the Civil Demand.

With such large offtakes in the scheme the supplies for civil consumption in some cities of the area wherein the scheme is in operation is likely to be adversely affected. To make up the likely shortages, at a meeting held at Agra on 6th November, 1944, the Central Command have agreed to give over any surplus to the extent of 50,000 eggs weekly at cost price ex-godown for civil consumption. This quantity will be distributed for civil consumption at important consuming centres like Lucknow, Bareilly, Nainital, Dehradun, Shahjahanpur, Cawnpore, Moradabad and Fyzabad, and a machinery is being set up for its effective distribution at these places.

For this, it is also proposed to treat the districts of Sitapur, Pilibhit, Lucknow, Bareilly and Nainital as semi-controlled districts. Neither any military contractor nor the staff of the Poultry Scheme will operate in these districts. All the offtakes of poultry and eggs in these districts will be distributed through trade channels under the control and supervision of the Provincial Marketing Officer, United Provinces, Lucknow, to the above named consuming centres and this will be in addition to the quantity available from the scheme.

It is also proposed to license all the egg and poultry collectors in the 16 districts allotted to the scheme and the 5 semi-controlled districts wherein the produce will be distributed through the trade channel.

For the remaining 27 districts in the province it is proposed to organise equitable distribution of poultry and eggs for the balance of the military demand and for other consuming centres for civil consumption indirectly through Agmark Egg Grading Station which are being opened at important places all over the province.

For fowls the military hospitals will have a priority over the civil demand in the 12 districts allotted to the scheme and until the requirements of the military hospitals are fully met, no fowls will be taken from the scheme for civil consumption.

# A BRIEF REVIEW OF THE EXTENSION OF IMPROVED VARIETIES OF COTTON IN THE UNITED PROVINCES

By

M. A. A. Ansari, M. Sc., Acting Economic Botanist (cotton paddy, & rabi cereals) to Government, United Provinces.

The United Provinces grow inferior types of cotton known to the trade as 'Bengals' (*G. arboreum var. neglectum forma bengalensis* H. & G.), with a staple length of 3/8″—5/8″ capable of spinning to 8′s—10′s realing. The crop which has decreased in area from an average of about 9½ lakh acres in the decennium 1917-26 to just over 5⅓ lakh acres in 1933-42, is generally held by the spinning industry to have degenerated in quality also. The causes for the decline in area have been several and have been very well summarized by J. B. Hutchinson, who says : "Among the causes contributing to the reduction in area are the competition of other cash crops, notably sugar cane; the fall in cotton prices, and a number of years of adverse weather conditions". He further says : "While the generalisation of quality degeneration does not appear to be well founded for the bulk of the crop in the Ganges-Jumna Doab cotton tract, it applies with much more force to the Bundelkhand tract which supplied the Harpalpur-Jumnapar styles, and to the cottons of Rohilkhand and Western Oudh known to the trade as Chandausi, Kashipur, and Madhoganj styles, the bulk of which consisted of fine linted but low ginning cottons. In the absence of improved types of suitable habit combined with desirable lint characters, yield and ginning percentage, the material economic response to low prices has been the introduction by the cultivators of seed of hardy, early, coarse linted but high ginning cottons from the west of the Province in mixture with the local finer linted strains."

Some of the recent causes for further reduction in the area are the demand of the mills for cottons of high spinning value and the closing of foreign markets for short stapled cottons resulting in the policy of the Government for the curtailment of area under the U. P. 'Bengals'. The 'Grow More Food' campaign is also expected to result in further reduction of area under short stapled cottons.

Since the year 1905, several attempts have been made for the improvement and extension of the cottons in the U. P. Dr. H. M. Leake (1905) undertook to improve the indigenous types by hybridizing them with superior cottons. This work was continued by his successor, Rai Sahib Ram Parshad Singh. As a result of this, a few strains which were superior in quality to the local 'Bengal' cottons were evolved. Out of these K22, C.1031 and C.402, gave very good

results. C.402 was recommended for cultivation with irrigation almost all over the province. After the opening of the Sarda Canal, a zone in the Hardoi-Unao districts was selected for concentrated efforts for the extension of C.402. A definite scheme for seed distribution and extension of this variety was launched in the year 1934 to which the Indian Central Cotton Committee contributed financially. The results of this scheme were, however, disappointing. The main reasons which contributed to the failure of this cotton were a series of unfavourable weather conditions, failure in the timely supply of canal water, severe competition with sugarcane, the more paying cash crop of the locality and the comparatively lower yields of this cotton under cultivators, conditions. The maximum area that this cotton could reach was 3,500 acres during the year 1933-34.

Simultaneously with Dr. Leake, the late Sir Bryce Burt took up the puestion of improvement of the U. P. cottons by acclimatizing American types. He succeeded in evolving superior strains like C.A. 4 and C.A. 9 and made strenuous efforts for their extension in Cawnpore, Etawah and Mainpuri districts. High prices for cotton during the last Great War (1914-18) helped this movement considerably and the area under these types reached to about 8,500 acres in the year 1921-22. On account of the insufficient irrigation facilities and the high incidence of leaf rollers, however, these varieties did not make much progress and gradually disappeared from cultivation.

Near about the year 1921, Burt isolated a fine linted strain, J. N. I., from the indigenous cottons of Jalaun, for Bundelkhand tract, but that also, after a number of years of extension, lost its attractive features and ultimately disappeared altogether from the field as a pure crop. The maximum acreage that this cotton could cover was about 2,000 acres in the years 1924-25.

In the western districts, where cotton is a major *kharif* crop, Dr. A. E. Parr worked on entirely different lines. Encouraged by the high prices which were obtainable during the last Great War even for the very coarse-linted cottons, he selected a strain, A.19, which on account of good yield and good ginning spread all over the U.P., and was greatly responsible for deteriorating the quality of even those finer stapled indigenous types which were known to the trade as Kashipur, Chandausi and Harpalpur styles. The Indian Central Cotton Committee, therefore, recommended that its cultivation should be restricted to the Western districts of the province only. The maximum area that it reached was 80,000 acres in the year 1930-31. It has now been abandoned as undesirable.

In the year 1919, the Indian Central Cotton Committee, recommended for a detailed survey of the indigenous cottons of the U. P. Accordingly, some parts of Rohilkhand and Western districts were surveyed and a strain C.520, was extracted from the indigenous cottons of Saharanpur. The strain is a promising one. The experiments carried out in Government farms and in cultivators' fields all over the province, during the last five years, have proved its superiority over unimproved *desi* cottons both in yield and quality. The yield of *kapas* per acre of this variety varies from 6 mds. 19 seers to 9 mds. 30 seers, under unirrigated and irrigated conditions respectively, that is a maund more in both cases than the yield of *desi* cottons. The highest area that this variety reached was 34,449 acres in the year 1938-39. During the year 1941-42 however, the area amounted to 22,722 acres only. This decrease was primarily due to the drought experienced during the season, which resulted in the failure of this cotton at most of the places where water supply was not adequate. The variety gives an increased profit of Rs. 15 per acre over unimproved *desi*.

In view of the demand of the local mills for cottons of high spinning value and the additional facilities for irrigation now available, fresh impetus to the

cultivation of American Cottons was given in the year 1936-37 and Perso-American, a single line selection from the material imported from Persia (Iran), was found to be promising. The experience gained in the Government Cotton Research Farm, Raya, (District Muttra), during the last several years has shown that it out-yielded even C.520, the improved variety of *desi* cotton, under irrigated conditions. It yields on an average 10 mds. 9 seers of *kapas* per acre, that is about a maund and a half more than the unimproved *desi*. With a ginning percentage of 32, and a staple length of 0.88" it is capable of spinning up to 31 maximum warp counts. The variety fetches a premium of Rs. 2 per maund of *kapas* and a profit of about Rs. 19 per acre over *desis*. The area under this variety has now reached from almost nil to about 8,500 acres, during the last 3 years.

At present C.520 and Perso-American are being recommended for general cultivation by the Agricultural Department. Pokharayan (District Cawnpore) provides a ready buyer of *kapas* of C. 520 and Perso-American cotton in Mr. J. N. Cocolas who owns a ginning factory over there. Mr. Cocolas distributes the seeds of C.520 and Perso-American cottons to the cultivators who sell back the *kapas* to him at a premium. While in the year 1940-41 Mr. Cocolas gave a premium of Rs. 1-8-0 for Perso-American, and annas 8 for C.520 over the *desi*, in the following year had increased the premium to Rs. 3 for Perso-American.

Perso-American also commanded a very good market in Ujhani (District Badaun for the last four years, where Prem Spinning Mills have even started subsidizing the cultivation of this variety of cotton. In the year 1940-41, the Prem Spinning Mills advanced Rs. 1,000 and in the following year Rs. 1,500 towards the engagement of *kamdars* for organizing sowing and collections. By this system, they were able to purchase at the factory gate, the produce of 574 acres at a premium of Rs. 1-12-0 per maund in the first year and of 3,170 acres in the second year.

The Indian Central Cotton Committee also have sanctioned a scheme for the distribution, extension, and marketing of Perso-American cotton in the Western U. P. On account of the increased demand of long stapled cottons due to war conditions, this scheme is very opportune and it is hoped would give good results.

As a preliminary to the improvement of the cotton crop of the province, the Indian Central Cotton Committee financed a survey of the cotton growing areas in the U. P. As a result of this, about 27,000 single plants of *desi* cottons were collected from the year 1933 to 1937, and, furthermore, a large number of *desi* and American cottons were obtained from outside the Province. In the year 1938, the Indian Central Cotton Committee sanctioned a five years' scheme for work on the material thus collected. As a result of the work carried out hitherto, strains are now available both from *desi* and American Cottons which are superior in yield and quality and have given increased profit over C.520 and Perso-American cottons respectively. It is hoped that after these strains have been further tested, they would meet to a considerable extent the demand for superior quality cottons in the U. P.

# FRUIT GROWING AND THE KEEPING OF BEES.

By

W. B. Hayes,

*Horticulturist, Allahabad Agricultural Institute.*

Will the keeping of bees help the fruit grower on the plains of India to secure better crops of fruit? An affirmative answer to this question seems to be implied by Mr. R. N. Muttoo in his article, 'Keep Bees for More and Better Fruit', published in the January, 1945 issue of the Allahabad Farmer. The author does not limit his remarks to any group of fruits, although the careful reader may notice that his illustrations are all taken from the temperate fruits. As the magazine has a wider circulation on the plains, where these fruits are not grown to any great extent, it might have been more fair had it been indicated that the article applied to temperate fruits, and that it was not known to what extent it applied to those more commonly grown on the plains. The advertizement of the Indian Bee Jurnal in the same issue is not only misleading in the same way, but contains a statement that all progressive modern fruit growers of the West find it profitable to keep bees in their orchards. This statement is not true. It would be difficult to find a more progessive group than the citrus growers of California, very few of whom keep bees.

The question seems to deserve further investigation, for no means of increasing production in orchards should be neglected. If it were obvious that the orchardist could justify his keeping bees by the amount of honey produced, as is frequently the case in temperate regions, then it might be said that until it is definitely known that bees are not required, they should be kept. Unfortunately, the keeping of bees on the plains seems to require considerable skill, and in very few instances thus far has it proved profitable. The types of bee found wild are not easily domesticated, and the domesticated bees have many enemies. One marvels at the way in which promoters of rural reconstruction advocate bee-keeping as a village industry, apparently oblivious to the many difficulties involved.

The question of the desirability of keeping bees to aid in pollination may be divided into two parts. Is pollination needed and likely to be improved by the presence of bees, and are wild bees likely to be present in sufficient numbers? It is recognized that sufficient evidence is not present to answer these questions in relation to all of the fruits of the plains. Obviously, bees are of no importance in the case of those plants normally pollinated by wind or by other insects, or of those producing fruit without pollination.

The mango is, by far, the most important fruit on the plains, and in this case the situation is not entirely clear. Burns and Prayag in Bombay found that the flowers were visited by many insects, especially flies, but that artificial cross pollination produced fruit only rarely, and that flowers from which insects were excluded often set fruit. It therefore seems doubtful if the bee is an important agent of pollination in the case of the mango. The problem is not very acute, however, for it is well known that a poor crop of mangoes results from insufficient flowering or from adverse weather conditions or insect attack. There is no evidence that lack of pollination is an important factor.

Probably, second in importance in India is the banana. The commercial varieties are seedless, and may require no pollination. It is frequently the practice to remove the 'heart' of the bunch after the fruit has set, and before the staminate flowers have opened. Unless attacked by disease, each pistillate flower develops into a fruit. There thus seems to be no pollination problem here.

Several citrus fruits are widely cultivated, and the flowers of all are very popular with bees, and some of the most delicious honey is produced from the blossoms of orange and other citrus trees. Pellet, in 'American Honey Plants', refers to two apiaries at the Atwood grapefruit ranch in Florida, where 'they hold that the trees bear a larger number of fruits since the bees have been kept in close proximity'. Frost in Chapter VIII of Volume I of 'The Citrus Industry,' edited by Webber and Batchelor, a very authoritative book published in 1943, discusses the question at some length. He says on page 785, 'Webber... concluded that in varieties with good pollen the pollination probably is usually adequate for satisfactory setting of fruit, even if no bees or other insects are present......The evidence available...indicates that pollination by bees is probably a negligible factor in the production of citrus fruits, at least of the varieties commonly grown in California.........The flowers produce an abundance of nectar that is especially desirable for honey production, but the presence of the bees in the orchard seems to have no significant effect as a rule on the crop of fruit.' Frost points out that bees are needed to secure large crops of one variety, the Clemantine mandarin, but does not state whether more bees are needed than are normally present. He also points out that in some varieties with few or no seeds when self-pollinated, cross-pollination causes increased seediness, and is therefore undesirable. Evidence regarding the citrus fruits in India seems to be lacking.

The guava fruit contains many seeds, and pollination is doubtless required. Numerous bees may be seen working the flowers, but it is not clear what part they play in pollination. If self-pollination is the rule the presence of insects may not be required, for the numerous stamens produce an abundance of pollen close to the stigmas. In the United Provinces, at least, heavy crops are the rule, indicating that if bees are necessary they are normally present in sufficient number. However, the question deserves further study.

Cross-pollination is definitely required in most of the commonly grown types of papaya, as the trees are monoecious. There seems to be little evidence as to whether pollination is brought about by wind or insects, or both, but in the United States it is considered that a moth is probably the principal agent. The possibility remains that bees may play a part, and that increasing the number of bees might result in larger, better fruit in some cases.

The date is also monoecious, and the need for pollination has been recognized for thousands of years. In all properly managed date groves this is provided by shaking a few strands of male flowers over the female spadix and tying them in it. Wind and insects complete the process. The writer has come across no indication that bees are kept to aid in this process, which gives entirely satisfactory results.

Pollination does present a problem in the case of the fig. European varieties are divided into three groups: the common fig, which does not require pollination; the Smyrna type which is pollinated by a very small wasp; and a few sorts which require pollination for the second crop, while the first develops parthenocarpically. Indian varieties frequently fail to set fruit, and recent work indicates that artificial pollination produces the desired results. How to secure pollination remains a problem, but even the smaller bees are too large to enter the syconium, so cannot be expected to help.

Custard apples are also known to benefit by hand pollination, but it is not known whether an increased number of bees would serve as well. In the case of a number of other fruits there is also the possibility that bees may perform a useful function, and that successful bee-keeping in the orchard would result in better crops. There seems to be no evidence, however, that this is actually the case.

It is desirable that any evidence which exists as to the value of bee-keeping in orchards be put forward, and that the whole question of pollination be studied in those fruits in which this has not yet been done. Until evidence is forth coming that more bees will help the orchards on the plains of India, should we not refrain from advocating their keeping for pollination, and at the same time wish all success to the enthusiasts who are striving to overcome the odds against the bee-keeper on the plains, so that delicious and nutritious honey may make a larger contribution to the food supply of the country?

# PHYSICS IN AGRICULTURE.

By

S. C. Bhatnagar, B. Sc. (Agr.), B. Sc. (Ag. Engr.)

The most outstanding contribution made by Physics to Agricultural science is in the study of soils. The soil is a complex mixture of solid, liquid and gaseous material. Mineral and organic matter form the solid phase. Water varying in chemical composition and the freedom with which it moves forms the liquid part filling a part of the pore space. The remaining porespace is filled by vapour. The study of the mechanical behaviour, the laws governing water supply, movement and retention, affect directly the plant growth.

Sir Humphry Davy (1813) was one of the first to study the physical properties of soils. Schubler followed (1833) and wrote a book on soil productivity and their physical concepts. He found out the specific gravity and water holding capacity of soils and its effect on volume. He described the heat capacity of soils including the effect of sunlight. This was followed by Schumacher (1864) who stressed Schublers works. Much interested in air and water movement in soils, he advocated the idea of capillary porosity. In 1877 Wollny wrote a monograph on the various soil properties affecting plant growth. He conducted various experiments by which he measured the interception of rainfall by foliage and its effect on runoff and erosion in plots of various slopes, soils, and vegetation cover conditions. He studied the various field operations, *i.e.*, ploughing, cultivating etc., in connection with their results on the plant and on the soil. About the same time some American scientists made outstanding contributions to the knowledge of Soil Physics. Hilgard in 1873 made an elutriator for making silt analysis. To help in water storage in soil Johnson (1877) advocated tillage practices. He studied capillary transmission and evaporation. (He gave more emphasis to the rate of movement than the distance of travel finding that water moves faster in moist and big pore soils than in dry and small pore soils. King (1888) found out the water requirement of various crops. He advocated the conservation of water by means of dust mulches produced by tillage. His theory of dust mulch was based upon evaporation losses from columns of soil in contact with free water surface. The conservation of moisture was due to tillage practices by increasing the water absorbing capacity and checking its escape by means of evaporation and transpiration through the weed leaves. Briggs worked on the mechanics of soil moisture. Buckingham worked on capillarity and the soil moisture movement. Patten made important findings on transference of heat in soils. From 1920 the interest in the physical properties was again revived. Most outstanding works of the recent days are by Keen and Handbuch der Bodenlehre.

The above is in short the history of the development of Soil Physics. The modern soil physics is a growth of the past twenty-five years. It is very interesting to note as how many loop-holes exist in a pure science when it is applied to practical problems, and how strangely findings of one can be applied to another.

Soil physists at Rothamsted worked out the mode of distribution of water films with in a porous material, which was a problem of pure physics. The researches in physical and physico-chemical properties of soil and clay which were solely worked as problems of soil physics have important bearing on the Ceramic industry, in the preparation of flour dough, butter, cheese and tooth paste making.

From the physical point of view soil is a mixture of particles of all sizes and shapes and is generally referred to soil texture. Fine gravel (grit) have diameter of particles ranging from 2 to 1 mm. while clay has diameters ranging from ·005 mm. and below. This shows the great variation from 2 mm. to minute particles. A soil material may be subdivided into fractions according to size of its constituent particles which is called the mechanical analysis. The determination of size of particles and the study or other physical properties are not only of interest to soil physist but to Engineers and all the more to Agricultural Engineers who are mostly concerned with problems involving soils. Construction of soil saving dams, irrigations canals, channels for drainage, foundations of buildings having quite a bit do with texture of the soil. In a mechanical analysis firstly the bigger particles are removed by sieving, while the other finer particles are removed by some form of dispersion method. To describe the various methods for determining the mechanical analysis is beyond the scope of this article.

Clay is the most important of all soil constituents. It is often subdivided into small fractions called ultra clay or colloidal clay. Many of the physical and chemical properties of soil are dependent upon the surface activity of the clay fraction. It has marked colloidal activities because of large amount of surface per unit weight of material. Sand and silt are primarily quartz or unweathered minerals which make the surface activity low. At Missouri they found out that coarse silt (20 $\mu$ to 5 $\mu$ dia.) possess only 1/10 of surface properties of coarse clay (2 $\mu$ to 1 $\mu$ dia.) and less than 1/20 of the absorptive capacity of colloid clay (less than 100m $\mu$ =1 $\mu$ ).

Clay soils retain water for a considerable time and drain with difficulty. Because of the higher moisture content they warm up less rapidly during the hot season and cool slowly in winter. The most important of all the properties is the crumb formation which consists of many individual particles bonded together by electric forces associated with the charged spots on the particle surface and with the neighbouring ions. These soils shrink while drying thus during dry weather soils crack which is harmful especially if a crop is standing on such a soil. When wet such soils cannot be worked without injuring the tilth of the soil.

By good tilth we generally refer to the pulverant condition of the soil which results from good tillage. It may be referred to a condition which all good farmers look forward to grow crops successfully. It is because of many factors of which the most fundamental is a good crumb structure. It is very closely related to aggregate formation since it is associate to the colloidal material. Sandy soils because of the size of the grains are well drained and are very seldom in bad tilth, but are very poor in storing moisture and food nutrient.

Organic matter plays a very important part in contributing to the aggregation of the soil. Its action is cementing in nature which is most probably due to a kind of adsorption of the humus by the inorganic soil colloid which brings about a stable union between organic and inorganic material with the help of dehydration. It is the decomposition of organic matter which is responsible for the structure formation in place of organic matter itself. According to Russel the more rapid is the decomposition the better is the structure. It has been found at Indore that addition of organic matter may improve crumb structure and finally the crop yield.

The growing crop affects soil structure in two ways. (1) Directly the plant leaves and stem protect the soil from the direct impact of rain drops which prevents the dispersion of the soil. Plant roots by binding action, by change of moisture percentage, by absorption and possibly by root excretions develop granulation and porosity. (2) Indirectly the crop provides organic matter which changes the granulation. Extra to organic matter the cementing material in certain soils such as laterite soils may be iron hydroxide, colloidal alumina may also aid in aggregation structure. Plant roots and soil can be imagined to have barter. The roots give off $CO_2$ and provided hydrogen is in intimate contact with the clay surface on which Ca, Mg and K and others are absorbed. The hydrogen from the root is a positively charged ion and exchanged for similar charges on clay. These positive ions on going into roots are synthesised in complexes which are carried up the plant. The humus is of great help in soil productivity. It works like clay because of the great absorptive surface. It too can exchange its hydrogen for nutrients in mineral. In addition it decays rapidly and give plant food of which it was originally constructed.

Cultivation of soil affects the soil structure in the following ways:—

Tamahane and Sreenivasan give the following reasons as how the structure of the soil is changed because of the cultivation. (1) It decreases the organic matter production. (2) Increased organic matter decomposition. (3) Increase in leaching. (4) Effect of the direct impact of rain drops on the soil. (5) Effects of the mechanical manipulation of tillage implements.

Plasticity, cohesion and surface friction between soil and metal surface of an implement influence the pull considerably. At Rothamsted they found out that in a plot 66ft. by 33ft. the draw bar pull varied up to 30 per cent. Such a variation is of great importance in comparative of competitive implement trials where it is essential to conduct the preliminary dynamometer survey. Other experiments show that addition of manures other than organic manure did not bring about any change. They found out that the drawbar pull is comparatively unaffected by the speed of the cultivation. An increase of speed from 2·25 miles to 3 miles per hour which meant 60 per cent extra work required 7 per cent increase in drawbar pull which resulted in saving the time and money due to increase speed. Such experiments call for better design of tractor to work satisfactorily under higher speeds.

## Soil and Water Relationship.

Water, its movement, retention and losses is of very great importance for the plant growth not only because, itself being a part of food, but as a carrier of soil nutrients. Dr. Keen describes the flow of water through soil as analogous to flow of heat or electricity through conductors which gives a great difficulty because the quantities corresponding to conductivity and potential (which for the heat and electricity are practically independent of the external condition and current density) are not independent of the moisture contents which dependent upon the state of packing and the colloidal content of the soil.

Soil water can be classified into three groups, *i. e.*, hygroscopic, capillary and gravitational. Many authors who regarded soil grains as inert units led them to subdivide these main groups still further, but the recognition of the soil properties as that of colloids has destroyed the validity of such additional groups. Hygroscopic water.—When dry soil is exposed to atmosphere it absorps moisture rapidly until the molecular attraction of the colloidal surface is satisfied. After the moisture absorption is done this soil can still hold some water in liquid form if added to it. This water held by the soil is called the capillary water,

If the addition of water is continued the capillary capacity is full and free water starts moving down because the action of gravity.

The capillary porespace can be divided into two parts. (1) Micro porespace—This is the porespace present in the crumb. (2) Macro porespace.—This is the porespace between the two crumbs. The inner capillary water is controlled wholly by the colloidal nature of the soil while the outer capillary water is held because of surface tensional and colloidal nature. There are four important factors which affect the amount of the capillary water. (1) Texture of the soil. (2) Structure of the soil. (3) Organic matter present in the soil. (4) Action of gravity.

The literature on soil water relationship reveal two schools of thoughts which differ slightly. The older concept is the capillary tube hypothesis which pictured the porespace of the soil as a set of capillary tubes varying in length, width and direction. Water relationship was thought as a function of the tension of the water films around particles. E. Buckingham, another representative of the Bureau of Soils, advocated the using of energy relations to explain soil moisture relations, which was further developed by Gardner, Haines and Keen. This has modified the old thought of capillary tube hypothesis just a bit.

**Failings of capillary tube hypothesis.**

The early workers in explaining the water relationship missed the implication of two sets of porespaces. They applied the ordinary capillary tube formula of pure Physics which states that the height of the miniscus is inversely proportional to the radius of the tube showing that the smaller the diameter of the tube the greater will be the height of miniscus. This led many to believe that as plants absorb water from the soil the water is replenished by capillary movement from the water table. All experiments conducted in the laboratory failed to show greater rise than three feet. These experiments were rejected by some on the ground that the failure may be due to uneven packing of the soil. At Rothamsted to avoid the soil packing factor they sunk iron cylinders six feet long and two feet in diameter in earth and filled them back with the soil in the same order as it had been excavated. These iron cylinders had observation tube on one side. For few years the soil was allowed to settle before any observations were taken. During the winter these cylinders got water logged. The descent of the water level was observed from the observation tube during spring and summer for several years. The results show that capillary rise was two feet in fine sand and three feet in ordinary soil. Leather in an article on the loss of water from soil during dry weather as early as 1908 published in the Memoirs of the Dep. Agr. Ind. pointed out that during dry periods water moves upward towards the surface of the soil from a limited depth only and is lost from the soil by evaporation. Barker at Nebraska Station found that the loss of water due to direct evaporation from the surface of the soil is a very small factor after the water becomes thoroughly distributed in the soil.

There are four forms of water movement. (1) Diffusion. (2) Film adjustment. (3) Percolation. (4) Thermal movement.

1. Diffusion.—This movement is because of unequal molecular attraction towards the point from where the water has been removed. This movement is rather slow but is the only way by which the moisture may be available to plant roots after they are isolated from the free capillary water.

2. Film adjustment.—This is also known as capillary movement. It is due to stress of pull developed by surface tension from the thick films and wedges to those that are thin. This has been discussed in detail just above.

3. Percolation.—It depends upon the texture and structure of the soil. In sandy soils water percolated much quicker than in clay soils, other factors being the same. The drainage problem has quite a bit to do with the percolation power of the soil. In soils where percolation is poor the tile drains are put much nearer the surface than in light soils.

4. Thermal movement.—This is divided in two classes. (*i*) Internal thermal movement. This refers to the movement of water vapour in the soil. (*ii*) External thermal movement.—This refers to evaporation.

## Problem of Moisture Conservation.

The average rainfall for India is 37 inches, which is more than sufficient for ripening of a normal crop other than such which require heavy irrigations like sugarcane or any other vegetable crop. Our ignorance about the principles affecting moisture conservation are mostly responsible for low yields. In a country like India where out of the total cultivated land only 16 per cent. has provision for artificial irrigation, it is all the more essential that our cultural methods should aim at largest conservation of the moisture.

## Methods of soil Moisture conservation

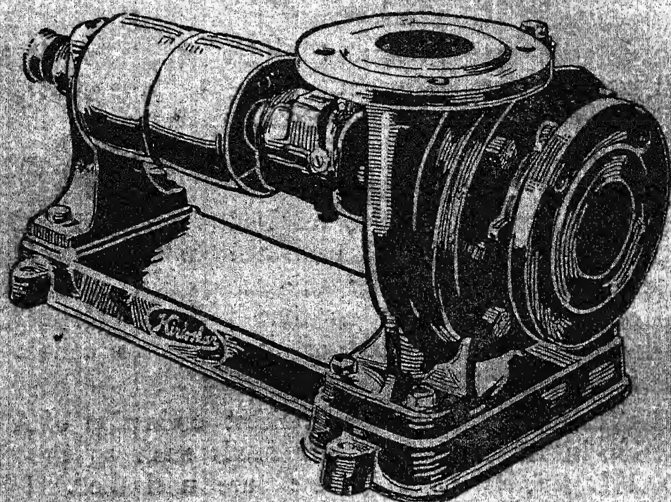
1. Increasing the absorptive power of the soil.—The first problem is to take care of all the moisture which falls on the soil in the form of rain. The irrigation commission reports that more than 35 per cent. of rain goes back to sea in our country where the soil just refuses to grow crops because lack of moisture. Absorption of rain can be increased by leaving the soil open and rough so that it can take care of all the rain falling. This will check runoff and erosion. When soil conditions are favourable for moisture absorption and the intensity of rain is not excessive very little water will be lost.

2. Increasing the water holding capacity.—Organic matter plays an important part because it increases the water holding capacity. It acts as a sponge in absorbing rain water.

3. Checking the loss of moisture from the soil.—Water loss starts immediately after the rain has stopped. If the soil has plants growing over it the moisture is lost by transpiration and evaporation. Soils free from plants have very little loss of moisture, actually there is very little loss of moisture from lower second feet except under very warm conditions. At Indore experiments were conducted on shallow versus deep interculture practice for a number of years and they came to conclusion that shallow interculture just sufficient to keep down the worst weeds has yielded best, while the excessive interculture resulted in injury as the soil structure was spoiled because of the trampling of the soil.

References :—

1. Journal of the Royal Society of Arts, July, 1942.
2. Physics in Agriculture—By B. A. Keen, Agric. Journal of India, Vol. XXII.
3. Nature and Properties of soils—Lyon and Buckman.
4. Crumb Structure and Soil Fertility—By Jamhane and Sreenivasan—Current Science, May, 1943.
5. Irrigation in Relation to soil moisture and plant growth—By F. J. Veihmeyer—Agric. Engineering, May, 1927.
6. Factors Influencing Soil Moisture Regulation—By R. W. Jrullinger—Agric. Engineering, July, 1927.
7. Physical properties of soil of interest to Agric. Engineers—By L. D. Baver, transactions of the A. S. A. E., 1932.
8. Factors influencing soil moisture regulation—By R. W. Jrullinger in Transactions of the A. S. A. E., 1927.



VOL. XIX] [No. 3


# THE ALLAHABAD FARMER

A bi-monthly Journal
OF
Agriculture and Rural Life


"In peace or in war food is as essential as the air we breathe."

—MARVIN JONES.

# THE ALLAHABAD FARMER

## A BI-MONTHLY JOURNAL OF AGRICULTURE AND RURAL LIFE


### MANAGING COMMITTEE

| | |
|---|---|
| *Editor and Business Manager* | Rev. B. M. Pugh. |
| *Contributing Editor* | Dr. Sam Higginbottom. |
| *Associate Editor* | W. B. Hayes. |


The Allahabad Farmer is now approved by the Directors of Public Instruction in the United Provinces, Bengal, Central Provinces, Sind, Assam, Bihar and Orissa, the Rural Reconstruction Commissioner, Punjab, and by the Director of the Institute of Plant Industry, Indore, and Agricultural Adviser to Rajputana and Central India States, for use in all schools under their jurisdiction.

### Subscription Rates

Annual subscription : India, Rs. 3 ; England, 4 shillings ; U.S.A., 1 dollar. Single copies, 10 annas ; over five years old, 12 annas. Copies which are not received by subscribers will be supplied free of cost within six months of the month of issue. Thereafter single copy prices will be charged.

Unused portions of subscriptions cannot be refunded.

### Advertising Rates

| | Rs. | a. | p. |
|---|---|---|---|
| One full page of six numbers | 35 | 0 | 0 |
| One single full page | 7 | 0 | 0 |
| One half page of six numbers | 20 | 0 | 0 |
| One single half page | 4 | 0 | 0 |
| Page 2 or 3 of cover for six numbers | 50 | 0 | 0 |
| Page 4 of cover for six numbers | 70 | 0 | 0 |

### Contributions

The Allahabad Farmer is published in the first week of each alternate month commencing with the month of January. Contributors are requested to send in their articles at least one month prior to the next prospective date of publication.

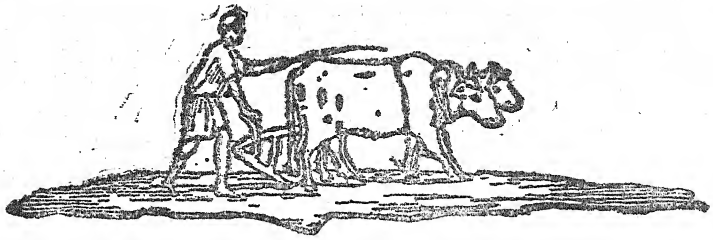
Contributors will receive 15 reprints of the article published and additional copies at cost.


*Publisher*—The Allahabad Agricultural Institute, Allahabad, U.P. (American Presbyterian Mission).

*Printer*—The Mission Press, Allahabad, U.P.


## CONTENTS

# THE ALLAHABAD FARMER



VOL. XIX] MAY, 1945 [ No. 3

## Editorials

**"Give Ye them to eat."**

This War has been an eye-opener to many in this country that the food situation is not as good as some of us had thought. We were, at least most of us, of the opinion that this country was self-sufficient with regard to the supply of food for the millions living in this country. India is such a rich country in its natural resources, *i.e.*, in matters of soil and climate, that it is somewhat difficult to imagine that the country of this kind should not be able to produce sufficient food for its people. It is true, of course, that a great deal of rice had, for several years, been imported into this country, especially to Bengal and Assam, from Burma; but this situation also did not need to exist even in pre-war days. The loss of several million people in Bengal and other parts of India due to the scarcity of rice has, therefore, made us realise that all is not well with us, and, more particularly, in the rice producing areas of this country. It is, therefore, time that we turn out our efforts in the direction of producing more food for the country so that such a situation may not arise again.

In the next few paragraphs we, therefore, wish to point out some of the ways by which the food production can be increased as we have experienced on the farm of the Allahabad Agricultural Institute.

This farm, when it was first taken over, was so poor that nothing but *kus* and *kans* were growing in it; but due to the various methods, which we have adopted ever since the farm has come into the possession of the Allahabad Agricultural Institute, it is now capable of producing much more food One of the things that were done in order to improve the food producing capacity of the fields, was to get the sewage water from the Allahabad Municipality. The Institute has been getting two lac gallons of this water daily. The area now covered by this sewage water is capable of producing three good harvests every year, while formerly it was not capable even of producing a very poor crop of *arhar* or *bajra* or gram. This area is now producing *juar* fodder for our 200 head of cattle, and vegetables almost throughout the year. Thus, not only are crops of various sorts being grown in this area but the yields of these crops are very much larger than they used to be when sewage water was not available. In spite of this very successful

experiment with sewage water in this area, there is still a considerable amount of sewage water which goes down to the Ganges and the Jumna polluting these two rivers. We know that such successful experiments with sewage water have been demonstrated elsewhere in various parts of this country, yet there are Municipalities all over the country which have not as yet taken advantage of this knowledge. We recommend this method of supplying water and fertilizing the fields in order to produce more food for the people of this country. This system is particularly suitable to areas near large cities where the supply of fresh vegetables and fresh milk is very often inadequate.

Another method, which has helped considerably to increase the fertility and thereby the food-producing capacity of our fields at the Allahabad Agricultural Institute, is the systematic method of levelling our land. The Institute authorities quite early realised that fields which are uneven produce very poor crops. The fertility of the land is often washed away by rain water in those lands where the surface of the soil is uneven, which results in very poor crops. The Institute, therefore, has, every year, made use of bullocks, which are otherwise unemployed during certain seasons in the year for this work of reclaiming or improving uneven land. With the help of the scraper or leveller large areas of this farm have thus been made even every year. This has made it possible not only to cultivate those lands properly but also to apply considerable amounts of manures and fertilisers, which are not easily lost now, as the soil is fairly even and can, thus, retain the fertilisers. Bullocks in India are not always employed throughout the year, which results in very great loss to the country as they have to be fed throughout the year. If these bullocks can be so employed during their off-seasons for reclaiming poor lands, areas which are more productive can be largely increased.

The Institute also very early took up the reclaiming of deeply eroded lands by building dams across the water courses so that the silt brought down by floods is not carried to the streams and rivers but is deposited in the fields on our farm In this way some of the water channels, which were about 15 feet deep, were filled up in the course of a few years so that they are now capable of producing at least two crops a year. It has been customary for us here at the Institute to grow a crop of rice or a crop of *juar* fodder in those fields during the *kharif* season and, later on, to grow a crop of potatoes or wheat in the *rabi* season. We still have some areas, which have not been filled up to the extent that we can grow two crops in a year, but these areas are now capable of producing a very good crop of wheat every year. This would not have been possible if we had not had these dams which would hold the water and prevent rain-wash during the rainy season. We recommend this method for eroded lands in various parts of this country in order to increase food production or at least to make lands suitable for the growing of some kind of vegetation which may be used for the grazing of cattle, which may thus help in the increase of milk production in the country.

There has been, during recent years, a demand for the increase of grazing grounds for cattle. When the country is so badly in need of fields for the growing of food for human consumption it seems to us unreasonable to make the fields, which are now used for the production of human food, into grazing grounds for animals. However, the Institute is adopting a method whereby the fields are capable of producing much more cattle food than an ordinary grazing ground would, by growing crops that yield a very high tonnage. We have on this farm such fodder crops as Napier grass, Guinea grass, lucerne, and cow-peas which give very high yields. This makes it justifiable to grow such crops in order that the milk animals may produce large quantities of milk for human consumption. Milk for most people of India is almost a luxury. It is, therefore, a question to us as to what fields should be

reserved for the production of fodder when there is not as yet sufficient food for the people of this country. Growing fodder is only justifiable when the amount of food value, which is obtained through milk per unit area, is greater than the amount of food which one can obtain through other kinds of crops such as grains from the same area.

More recently, the Allahabad Agricultural Institute has also adopted a method of contour cultivation in order to prevent soil erosion. This consists in making small terraces on almost level land in order to prevent the carrying away of the surface soil through rain water. This has resulted not only in the conservation of rain water, but also in the prevention of soil erosion and, therefore, the removal of soil fertility, as the surface soil is usually the richest in plant foods.

Another method, which has been used in this institution in order to increase the fertility of the soil, is the composting of farm waste, which includes stubbles, vegetable waste, kitchen waste and any other materials from bungalows or even road sweepings. The use of this materiel as an absorbent layer in composting with farm yard manure has increased the available manure on the farm considerably. This has made the farm almost self sufficient with regard to its manure; *i. e.* with the help of this home-made compost we are able to manure each field once in three years. However, for fields that give very high yields of crops we reinforce this manure with oil-seed cakes, whichever are the cheapest in the market. Recently, we have found castor-cake to be the cheapest and have used it considerably.

Another method, which we have used extensively on this farm in order to increase the fertility of the soil, is the growing of a green manuring crop, such as sunnhemp. This, we believe, is one of the cheapest source of manure for the soils of this province. It is capable of adding some 60 pounds of nitrogen per acre, which is the amount needed for a fair crop of wheat.

Recently, we have been able to get a tube-well, which is now capable of irrigating about 40 acres of our farm. These 40 acres, which are controlled by this tube-well, are now capable of producing at least two crops a year, where we were able to produce only one crop a year, and that also a very poor crop. We now grow vegetables, wheat and some of the best yielding crops in this area. We believe that an extension of the tube-well system in this province would increase considerably the amount of food that can be produced.

If these methods are utilized and the resources mentioned are made use of, we believe that this country is capable of producing not only enough food for its population but also some that can be exported to other countries. This country, as we have stated above, has been favoured with some of the best soils of the world—the alluvial soils of the Indo-gangetic plan—and also with the best climate, which is conducive to the growth of most kinds of crops. While most countries of the world are capable of producing only one crop a year, our experience here at Allahabad has shown that we can grow at least three crops a year when properly managed. With these facilities our country should have no occasion to face starvation at any time.

# A NEW EXPERIMENTAL FARM

By

Mason Vaugh

*H. S. Azariah & S. C. Bhatnagar.*

The Allahabad Agricultural Institute has been faced with two somewhat conflicting interests: on the one hand, the need for and the importance of irrigation wherever it may be possible has been fully realised. The importance of irrigation and its value to us in the routine carrying on of the farm attached to the Institute has been very much in our minds. On the other hand, it was realised that at present only about 15 per cent. of the total cultivated area of India is more or less adequately irrigated by canals, and tube wells, another approximately 15 per cent. gets some irrigation from wells, tanks and inundation canals, and some 70 per cent. gets no irrigation. Probably, more than 70 per cent. of the actual cultivators lack irrigation facilities because the irrigated farms average being larger in area than those found in the unirrigated sections. The Agricultural Departments and Agricultural College staffs tend to simply assume irrigation in anything they do or recommend, and to neglect the problems of the farmer who lacks irrigation. This is not universally true, but it is definitely a tendency.

A third interest which did not particularly conflict with the above two, that of the testing of implements in field use, did tend to conflict with the general work of operating the Institute farm: the work being done on implements, the establishment of the new course in Agricultural Engineering, and certain special problems referred to us by the Agricultural Department of the U. P., made it desirable to have increased freedom to test implements and procedures involved in their use without having to consider the possibility of interfering with the regular farm work.

The Institute owns a plot of about 40 acres, lying at about half a mile from the Institute compound and on the other side of the E. I. Railway. The land is in the form of a long strip, irregular in outline but about 3 times as long as wide. It is rough, eroded land, low in fertility for the most part, infested with a mild to bad infestation of *kans*, *khus* and *dubh* grasses and other weeds. Because of its location it was inconvenient for the regular farm staff to give it the necessary attention. Its low fertility did not encourage intensive use. While bounded on one side by parts of the Municipal sewage farm, it was not practicable to arrange for irrigation of more than a very small part of it from this source. There was no well on the land even for drinking water.

Beacuse of all these considerations, it was decided to set aside this plot as an experimental farm, to be operated as a separate unit in all respects except the marketing or other disposal of the crops grown. Because the experimentation was to centre mainly round the development of suitable implements for the use of the small farmer and the procedures for their most effective utilisation, the operation of the farm was put under the agricultural engineering department of the Institute. The arrangement is that the engineering department makes all decisions and supervises the work of preparing the seed bed, planting, cultivation and other processes in growing the crop, decides what crops are to be grown and how much of each. The accounts from day to day are kept by a member of the engineering department but are reported to the farm manager's office and become part of the general farm accounts, though in the process of reporting them, separate figures are maintained for the experimental farm. When a crop is ready for harvest, the fact is reportad to the farm manager who is responsible for disposing of it. Crops may be harvested by the experimental farm crew or by the farm manager's men as may be decided in consultation. While the engineer-

ing department is in charge, the other departments of the Institute are available for consultation and are expected to make suggestions when they wish. Most departments have co-operated during the current year in one way or another.

There has been a bit of difficulty in deciding on a name for the farm. The term "dry farming" did not seem to fit as Allahabad gets around 35″ to 40″ of rain annually. "Non-irrigated" is awkward, besides being negatively stated, thus putting the wrong emphasis. "Rainfed", while definitely not entirely satisfactory, seems to be the best term in common use and so is the term used for the present. Perhaps a better term can be found or coined to express the idea.

The engineering department took over control of the farm from July 1st, 1944. A very small mud hut had been used by a *chaukidar* before. To this, a small wooden cottage was added to provide accommodation for one family to live on the place and a simple shelter was made to give room for 4 to 6 animals. In November, two silos, 6′ in diameter and about 28′ deep were dug and filled with *juar* fodder from which the grain had been removed. As the soil was very hard and firm, the silos were not lined. A shed will be made over them before the next rainy season.

Most of the land had been ploughed since there had been any considerable rain. As soon as the monsoon arrived—it was late as no important rain fell till July 4th,—about 30 acres was seeded to *juar*. This was planted in lines 30″ apart, with a 5-row seed drill, without any further preparation of the soil after dry weather ploughing. Two or three small areas which got weedy before seeding was finished were reploughed with small soil inverting ploughs.

As soon as the plants were large enough to follow the rows, interculture was started. A Wah-Wah 5-tined cuttivator attachment and a Shabash cultivator were used throughout. All the area was covered once and about 14 acres was done twice. The seed rate was probably too high but the crop set seed well and matured a good crop considering the low fertility of the land. Considerable experience was gained in the matter of interculture which should lead to improved results in future years.

Maize was planted on about 1 acre of the highest land on the farm which is also the lightest and sandiest plot. Growth was very poor and only about 30 mds. of fodder was secured with 30 seers of green cobs. The same plot was later prepared and seeded to gram in the *rabi* which made good growth and the yield was 16 mds, 10 seers.

A small plot of about one-third acre was planted to sweet potatoes. The land was poor, a low part of the field carried the rain water turned into the field from a roadside drain and the growth was not as good as was expected. Several different methods of setting the cuttings were tried and the results noted. They will be further checked and announced when the results are more conclusive. Methods of weeding and interculture were also studied.

About 1/8 acre was seeded to small plots of *guara* of an improved variety, two varieties of cowpeas and other legumes for comparison purposes. The season was unfavorable for interculture and due to pressure of other work, some of the plots were not given full attention. The results with *guara* were encouraging and the area will be increased next year. Other trials will be continued.

The area being rather badly eroded, it contains several quite long bunds and embankments which are not suitable for cultivation. A certain amount of grass is harvested from these but the total amount is not large and they tend to be infested with *kans* and *khus* grasses. In an effort to increase the production of these areas, *arhar* was seeded on them early in the rains. In certain places, seeding was carried out with a seeding spout behind a plough; most of the area

was seeded by dibbling with a *kurpi*. This was done by a boy, sitting under an umbrella, on days when it was raining. Germination and growth was irregular but a number of places had quite good crops on them. The seed was being harvested by various methods not involving cutting the whole plant, in the hope that the plants would live several years and increase in size and vigour from year to year. Following a late rain in February, 1944, some areas are being seeded experimentally in the hope of having the plants well established when the next monsoon starts new growth.

Nearly 10 acres was set aside for *rabi* crops and seeded to sannhemp. The land had all been ploughed in the dry weather so just before the monsoon started, when it began to appear that rain could be expected soon, the seed was simply broadcast. No further preparation of the soil subsequent to ploughing was done, nor was any further operation done subsequent to broadcasting the seed. Melting of the clods provided sufficient cover and germination and growth were good. Due to an abnormal rise in the Jamna River, part of the area was flooded, killing the sann. On the remaining area, growth was very heavy and the rains were unusually constant and continued late so that considerable difficulty was experienced in turning under the sann. Eventually, due to these circumstances and the fact that much of the area was very badly infested with *kans* and *khus*, only some 7.5 acres were seeded to wheat. On the better areas germination was good and growth has been satisfactory. A considerable area was found to be very heavy sticky clay which dried very rapidly and which lacked organic matter so germination on these areas was poor. The remaining area not seeded to wheat was ploughed twice, clearing out the *kans* and *khus*. It is hoped that with continued attention during the coming dry weather, the grasses can be so controlled that no great difficulty will be experienced in future years.

When the rainfed farm was established, the Institute farm was short of work oxen and, due to the war, it was difficult and expensive to buy others. There were a number of cows available; so some of them were broken and nearly all the work on the farm has been done with them. Because the cows were not yet really trained to work, a pair of oxen was borrowed from the Institute to seed the juar crop with the seed drill. For a time during September and October, only three cows were available; so a bullock was hired to complete the second pair. It proved to be inferior to the cow with which it worked. Two of the cows were nearing the end of the lactation when taken over. They finished the lactation normally. It was necessary, because of a fodder shortage to change their feed several times. So far as could be estimated, variations in the milk yield was no more than would have been expected from the change in feed. All the cows used were either barren, had not bred for several years or were Bang's disease reactors. Two came into heat, were bred and carried the calves to a normal birth. Unfortunately, both calves died soon after birth, apparently due to causes not connected with the mothers having worked. One has not come into heat at all.

After a little trouble in breaking them to work, the cows have worked quite satisfactorily. They are comparatively small, weighing about 700 lbs. When the farm was started, no fodder was available on the farm; so chopped fodder was taken daily from the Institute farm. From about the middle of July, grass, weeds and crop thinnings became available on the farm and from the middle of July till the end of January no other roughage was used. Since then they have been fed as much sillage as they would clean up. They are given 4 lbs. each daily of the standard concentrates mixture used in the Institute dairy heard.

Various implements have been tried. *Juar* and all the *rabi* crops were planted with a 5 row grain drill, 3 spouts being plugged, for *juar* so the rows were spaced 30″ apart. Maize was planted with a single row maize planter borrowed from the Institute farm. As mentioned above, sann was broadcast.

Part of the area under sann was re-worked with a sweep to remove *kans* grass after the sann was broadcast. It was feared that this re-working had buried the sann seed too deeply, so a light seeding of cowpeas was broadcast by the same method. This germinated normally but the sann also germinated well and tended to swamp out the cowpeas.

Turning under of sann was started with an old soil inverting plough about 8" size. Two were available but it was found that they were a very heavy load for one pair and entirely out of the capacity of the other. It was found that a short beam Shabash plough, fitted with a rolling coulter, did unexpectedly good work. It did not get all the sann covered but most of it was and the rest was uprooted so that it died and was worked in to the soil in subsequest operations. Both Wah Wah ploughs and Shabash ploughs fitted with the usual long beam were tried but found definitely inferior to the Shabash fitted with short beam and chain hitch. A. U. P. No. 1 was also used quite satisfactorily later in the season. It was not fully tried for turning under sann. It will be in the next season. Interculture of the juar and maize was done mostly with bullock cultivators, both Shabash cultivator and Wah Wah cultivator attachment being used. The workmen were allowed to use whichever they preferred and enough equipment was made available so that they had free choice without having to ask. Both types proved useful but under the conditions prevailing, there was a slight preference for the Shabash cultivator. Hand weeding of the *kharif* crops was done only incidental to getting grass for the cattle except that a little trial was made of the hoe for cutting out weeds among the maize and hoes and garden rakes were used in cultivating and weeding the sweet potatoes. As much of the land was rather badly infested with *dubh* grass, lamb's quarter (batwi), *ankra*, *chaurai* and Mexican poppy, the small area of rice and the wheat has been weeded with the *khurpi*.

The cultivators equipped with the ordinary shovels or cultivator steels and also with large sweeps were used to good advantage in preparing the *rabi* seed bad. The cultivator equipped with shovels was found useful for stirring the soil when it had only ordinary seeding weeds, not too well established. The Shabash cultivator equipped with a 24" wide single flat sweep did good work in lightly infested *kans* land and where there were seedling weeds. A similar sweep did well on the U. P. No. 1 plough.

For light surface mulching particularly on light loam soil, the Acme harrow proved useful. No spike tooth harrow was available in the early part of the season and there was no opportunity to use it after it was available. It will be tried for various uses next year. A *patela* (drag or planker) of the pattern used with one pair of bullocks in Kumaon, was made and used affectively. It seems to have advantages for the small farmer in not requiring ropes or chains and in being workable with one pair of animals where two are generally used locally.

TABLE 1.

*Distribution of the Use of Implements (in days).*

| | | Ploughs. | | | | | | Cultivators. | | | | Harrows. | | | | Seeding. Implement. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Wah-wah Mould board. | Shabash. | Soil Inverting M. B 8" plough. | Sweep. | Wah-wah Rooter. | U. P. Rooter. | Wah-wah. | Shabash | Others. | Knife. | Spring tooth. | Spike—" | Acme. | Knife. | Corn planter. | Wah-wah malabasa. | Seed-drill. |
| July | 1 | 3 | ... | ... | ... | ... | ... | ... | ... | 1½ | ... | .. | ... | .. | ... | 2½ | | 1 |
| | 2 | 12 | ... | ... | ... | ... | ... | ... | ... | 1½ | | | | | | | ... | |
| | 3 | 1 | ... | ½ | ... | ... | ... | ... | ... | 18 | ... | ... | ... | ... | ... | | ... | 9 |
| Aug. | 1 | ... | ... | .. | ... | ... | ... | ... | ... | 5½ | | | | | | | | |
| | 2 | ... | ... | 3 | ... | ... | ... | ... | ... | 6 | ... | ... | ... | ... | ... | ... | ¼ | |
| | 3 | ... | ... | 8 | ... | ... | ... | ... | .. | 2 | | | | | | | | |
| Sep. | 1 | ... | 10 | 6 | | | | | | | | | | | | | | |
| | 2 | ... | 5½ | ... | ... | ... | ... | ... | ... | ... | 2 | ... | 1 | 3 | | | | |
| | 3 | ... | 7 | ... | ... | ... | ... | ... | 1 | ... | ... | ... | ... | 2½ | | | | |
| Oct. | 1 | ... | 12½ | | | | | | | | | | | | | | | |
| | 2 | ... | 4 | ... | ... | ... | ... | ... | 3 | ... | ... | ... | ... | 7 | | | | |
| | 3 | ... | 7 | ... | 6 | ... | ... | ... | 4 | ... | ... | ... | ½ | | | | | |
| Nov. | 1 | ... | ... | ... | ... | ... | ... | 3½ | 2 | ... | 5 | ... | ... | 1 | ... | ... | ... | 3 |
| | 2 | ... | ... | ... | ... | ... | ... | 1 | ... | ... | 10 | ... | ... | ... | . | ... | ... | 3½ |
| | 3 | ... | ... | ... | ... | ... | ... | ... | ... | ... | 11 | ... | ... | ... | ... | ... | ... | 2 |
| Dec. | 1 | | | | | | | | | | | | | | | | | |
| | 2 | ... | ... | ... | ... | ... | 3 | ... | ... | ... | 3 | | | | | | | |
| | 3 | ... | ... | ... | ... | .. | 4 | | | | | | | | | | | |
| Jan. | 1 | ... | ... | ... | ... | 7 | 8 | | | | | | | | | | | |
| | 2 | ... | ... | ... | ... | 8 | 7 | | | | | | | | | | | |
| | 3 | ... | ... | ... | ... | 1 | 9 | | | | | | | | | | | |
| Febr. | 1 | 9 | 9 | | | | | | | | | | | | | | | |
| | 2 | 8 | 8 | | | | | | | | | | | | | | | |
| | 3 | 7 | 7 | | | | | | | | | | | | | | | |

Experiments during this year have been largely confined to work with soil preparation and interculture implements. Most of the *kharif* harvest was done by the institute farm crew, only the fodder which went into our silos, the rice and some small plots of legumes being harvested by the rainfed farm staff. Some trials were made of a new type of *hansia* (sickle) with a long handle. These were inconclusive and will be repeated next year. Some trial was made of the sled harvester for cutting juar fodder but the cutting was delayed till the seed was ripe. The weight of the head on stalks made comparatively thin by both rather poor soil and rather thick planting resulted in so much bending over of the stalks hat it was found impracticable at that time.

Two mature men, two boys about 15 years old and one woman, the wife of one of the laborers, have been employed throughout the year. The woman has been largely occupied with providing grass, fodder gleanings and roughage for the animals, either from the bunds and embankments or from the fields. At times of rush-work she has helped with weeding, the weeds removed going to feed the animals. Additional labour has been employed during the weeding season for the rice and for the wheat. A *chaukidar* was employed for some time when the juar was ripening as there was some stealing. When the farm is cleaned up somewhat, it seems that this will be an adequate force except for harvest. Some extra help will be required for harvesting unless improved equipment is developed to reduce the labour demand. There has been work for the whole group throughout the year up to the end of February when this is being written, and it appears that there will be till the end of March. The work animals have only been idle a few days when rain interferred with field work or when only one pair was required during harvest for carting the crop in from the field. This works out to one man, one boy and approximately one woman part time caring for 20 acres of crop, except for a little additional help at harvesting.

The season has been only moderately favourable. The first appreciable shower did not come till July 4th and the second, giving enough moisture in the soil to make sowing advisable, did not come till July 7th. During August and early September, the rain was very continuous, no long breaks occuring to allow preparation of the rabi fields. A good rain the middle of October, a shower in January and another in February have helped to keep the soil moist enough to allow dry weather ploughing to be done by one pair of animals to the plough and the use of the small steel ploughs for it. Total rainfall has been about the normal and moisture has been sufficient.

One other development may be mentioned. It was found that to do the best work and to ease the strain on the animals, it was necessary to keep the shares of the ploughs and the sweeps quite sharp. A small anvil of a special type and a cross pein hammer was provided and the head man has learned to sharpen the shares himself. The shares are not hardened so can be beaten out cold. After some time, perhaps twice or three times in the life of the share, it will be desirable to have a blacksmith heat and draw out the edge when it gets too thick. Having this simple equipment and two wrenches, it is easy and does not take long to remove the share, beat its edge out quite thin and replace it. The workmen have appreciated the usefulness of this and themselevs see that the shares are kept sharp. A file has been provided but apparently little used, the beating of the edge being sufficient.

It is planned that the experiment should continue for some years more. Items for immediate investigation are (1) continuation of trials of improved implements and practices associated with their use, particularly for seeding, interculture and harvesting, and (2) the effect of various cropping schemes on implement needs and on labour demand. We particularly hope to develop combinations of cropping schemes, cultural practices, and implements use practices which will enable the small farmer, particularly the small farmer not having irrigation facilities, to most fully occupy his time and to derive the greatest profit from his efforts. Study of varieties of crops and related problems will come into the scheme only in so far as they are related to the exigencies of the other experiments. Plant breeding or the selection of varieties does not form a part of the plan, but undoubtedly, the results will in some cases, call attention to the need for varieties having certain characteristics. We plan to publish annual progress reports and observations.

TABLE 2.

*Moisture penetration.*

| Date. | Rainfall as recorded in the institute. | Moisture penetration. | |
|---|---|---|---|
| | | In inst. fields. | Cultivators fields |
| 26th June | ·64 | $2\frac{1}{2}''$ to $3\frac{1}{2}''$ | 2″ |
| 6th July | ·54″ | 4″ to 5″ | 3″ |
| 9th July | ·13″ | $6\frac{1}{2}''$ to $7\frac{1}{2}''$ | 4″ to $4\frac{1}{2}''$ |
| 15th July | 1·07″ | 20″ | 10″ to 12″ |
| 19th July | (·21) on 16th and 17th July. | 27″ to 29″ | |
| 22nd July | 1·27″ | 31″ | |
| 28th July | ·78″ | 3[illegible]″ | 15″—21″ |
| 5th August | 4·10″ | 4[illegible]″—4[illegible]″ | |
| 7th August | 5·50″ | 5 ft. | 32 —40″ |

# SILAGE MAKING IN THE VILLAGE*

BY

MASON VAUGH

*Agricultural Engineer, Allahabad.*

There has been general recognition of the fact that one of the difficulties which limits the improvement of cattle in India is the lack of feed and fodder. It is generally understood that, at least at certain seasons of the year, there simply is not enough fodder available in most villages and that much of what is available is not of high nutritive value. It is also true that, at other seasons, there is a considerable amount of fodder available, often more than the cattle can use immediately to good advantage. Some, at least, of the grass available is not suitable for use as hay, and much of it cannot be made into hay because of climatic conditions at a season when it has the greatest feeding value. By the time the climate has become suitable for hay making, the grass has matured beyond the stage where it makes good hay and the pressure of other work diverts the attention of the farmers away from preserving hay. The stovers of the sorghums and millets and of maize, when dried, are easily preserved but the feeding value is relatively low as compared with the fresh one. Though some hay is made in certain areas and the stover is usually saved, it seems probable that the comparatively poor quality of hay and stover feed does not encourage the farmer to be as careful as he might be either in gathering or in using them.

## Feeding value of silage

The value of silage as a feeding material has been widely recognized. It is known that good or at least moderately good silage can be made from a wide

*Reprinted from INDIAN FARMING, Vol. VI, No. 6, June 1945.

variety of materials and that some stuffs that are not readily eaten by cattle in any other form are readily eaten and are nutritious when made into silage. The silo has been fairly widely adopted by military dairies and large institutions, sucheas agricultural college farms. Only a few large private farms may have mad silos. In a general way, there has been a wide understanding of the possible value of the process of ensiling as a means of storing the fodder supply for village cattle and a number of articles and speeches have recommended it. As yet very little seems to have been done by way of experiment to determine the limitations of the process as a means of preserving fodder in the village. What are the possibilities of introducing silage making as a generally accepted process in the village? What are the difficulties? It is practicable to overcome them? If so, what steps are necessary and who should take them?

The material for silage making is not difficult to obtain. Any such material when put into a suitable container in the proper condition of maturity and moisture content will go through the fermentation process and be preserved as silage. The range of material which is suitable is wide. Any of the crops, such as sorghums, millets, maize and similar large stalked crops are excellent and can be used even when immature or over mature. Any of the wild or tame grasses ordinarily eaten by cattle and even others, which are not readily eaten green such as *kans*, can be ensiled. Many of them make quite good silage if properly handled. Wheat, oats and barley are quite good for ensiling. Legumes make an excellent addition to any silage and can even be ensiled alone. Proper handling involve either the addition of an acid preservative or the wilting of the legume to not more than 65 per cent moisture before ensiling.

## Process of making silage

The technical process itself is not difficult. Any suitable material, containing necessary moisture when put into a container or under conditions which will exclude the air and retain the carbon dioxide given off during the fermentation, will ensile, *i.e.*, go through the fermentation process. Except in the case of legumes where there is an upper limit on the permissible moisture, the moisture content is not critical. It may be anything from that of lush green half-grown material to that of fodders from which the seed has been removed, but which are still somewhat green. The highest quality of silage usually comes from crop material which is nearly mature, has the seed formed but not hardened, and is still green and juicy. Excessively green juicy material may make a sour silage. If the crop is too dry, the fermentation may proceed to a point where the temperature rises high enough to cause charring or burning of the substance. This can be easily prevented by the addition of some water to the material when it is put in the silo. Even completely dry stover can be ensiled if wetted when put into the silo, though the quality of silage is not so good as one obtained from a more suitable substance. Chopping or chaffing of the material is not necessary to the ensiling process but will be necessary in order to get the animals to eat all the coarser stalks. Even after ensiling, large stalks of coarse material will not be eaten when fed whole or unchopped. It is quite practicable to make grass silage without chaffing. The tougher grasses cannot be satisfactorily chaffed because of the amount of fibre they contain. The making of silage from whole fodders is not, in the author's opinion, advisable. Experience at the Agricultral Institute has shown excessive wastage when ensiled whole fodder is fed. The chaffing of ensiled whole fodder has been found to be impracticable even with large power machines.

At least in many parts of India, there is no technical difficulty in making a silo. Where soil conditions are suitable, the pit silo is both cheap and satisfactory. It may be either the deep circular type or the trench type so far as the technique of making silage is concerned. Good silage can be made in either type. The

trench silo is unsuitable for very small numbers of animals. Where the number of cattle is sufficient to eat the amount of silage which must be removed daily, as will be explained later, the trench silo is cheap and useful. Tower silos are left out of this discussion at this stage because they are more expensive. Their construction also requires much more skill and knowledge. For the early stages of the introduction of the silo under village conditions and for small herds, the deep circular pit types is definitely the most satisfactory.

Where the soil is firm, no lining is necessary. But if the soil is very sandy and likely to cave in, lining of some sort will be essential. For silos of small or moderate diameter, a lining of 4½ in. thick bricks will be ample. Where bricks are not available, cement plaster applied directly to the soil, can be used. In stony areas where the soil is shallow, the making of silos is difficult, but not impossible. Silos even 10 to 15 ft. deep partly below and partly above ground, are practicable almost anywhere. For large herds it is possible to make a fair grade of silage from grass by simply staking the grass, when it is wet and green, in the same way as hay is stacked. The outside will dry into hay, there will be a layer of musty, mouldy material inside the hay which the animals will readily eat and the centre of the stack will be silage. Making silage in such stacks is only suitable where the number of animals is large enough to eat the required amount produced daily from a large stack. It is not a suitable method for the use of individual farmers having only a few animals.

## Limiting factors

If the process is so simple, why has it not been more widely adopted? What are the limiting factors and the difficulties to be overcome before it can be generally introduced in the village? There are two kinds of difficulties: (1) Design and demonstration of the silo on a scale suited to the needs of the villager and (2) making available the necessary equipment.

The silos so far used in India, or in the western countries for that matter, have been much too large and generally far too costly for use in the villages. The two dimensions of a silo are determined by entirely different factors. The depth is determined by the length of the feeding season during which silage is to be fed without refilling the silo. A minimum depth of 2 in. per day must be provided, because a minimum layer of 2 in. preferably 3 in. of silage per day must be removed. Otherwise, mould grows in the silage and spoils or lower its quality. If silage is to be fed for six months (180 days) in the year, the depth must be $2 \times 180$ in. $=$ 360 in. or 30 ft. if 2 in. per day is provided or 45 ft. if 3 in. per day is to be fed. Longer or shorter periods of feeding can be provided for by greater or lesser depths. This is the total depth of silage required. Thirty feet depth of silage can be obtained from one silo 30 ft. deep, two silos each 15 ft. deep, or three each 10 ft. deep, though the actual capacity of two 15 ft. silos is slightly less than one of 30 ft. and the capacity of three 10 ft. silos is still less because the weight of silage in the deeper ones compresses the lower layers to a greater extent. Silos of 10 ft. depth can be made practically anywhere.

The minimum diameter of a silo is that in which a person can work conveniently to dig the silo and to remove the silage. Good silage can be made in an ordinary oil barrel or even in smaller containers. However, the minimum diameter for a pit silo should not be less than 4 to 5 ft. Deep silos of small diameter may be difficult to ventilate and may involve some danger of the accumulation of carbon dioxide in dangerous quantities especially at the time of filling. Even larger silos should not be entered in the early morning after partial filling before the air has been stirred up by filling in additional fodder. There is little danger of such accumulation of carbon dioxide except at the time of filling. If we accept 5 ft. as the minimum desirable diameter, such a silo will have a cross sectional area of about 19.6 ft. or 1 ft. depth will contain 19.6 c. ft.

of silage. If we feed 2 in. per day, we would have to feed 1/6th of 19.6 c. ft. or 3.27 c. ft. per day or about 100 lb. of silage, assuming that silage weighs about 30 lb. per c. ft. This calculation means that the minimum herd for which a silo can be made is one which will eat 100 lb. of silage daily. Four cows or oxen or three buffaloes may eat this much. Buffaloes at the Agricultural Institute are fed 55 to 60 lb. per day and milking cows about 40 lb. Work oxen are given about 40 lb. This is probably more than the average villager will feed. So we may say that the minimum size silo which is practicable is one which is suitable for a villager having four animals. The 100 lb. per day which must be consumed can be distributed among more animals.

Can silage be made available to those having fewer than four animals? I do not consider it desirable to advise a silo for a villager or anyone else who wishes to feed less than 100 lb. of silage daily. Various suggestions of joint ownership of silo and silage have been made and will provide excellent material for those wishing an academic debate. There are villagers who have four or more animals and who would be prepared to feed 100 lb. of silage a day. We cannot at once provide silos for or persuade all the cultivators in any given area to take up silage. If we start with those, who can use such a silo perhaps the villagers themselves will work out their own system of co-operation. In any case, when we have got a reasonable number of such silos built, we will have definite demonstration material available with which to work in convincing others.

## Size and quantity

How much material is needed to fill such a silo? A silo 5 ft. in diameter would have a cross sectional area of just under 20 sq. ft. If we provide a minimum of 45 ft. depth of silage, this gives 900 c. ft. of space to be filled. Taking the average weight of settled silage made from *jowar* with most heads removed, but with some greenness still in the leaves and stalks as about 30 lb. per c. ft., this volume of silage would weigh 27,000 lb. or 13.5 short tons or approximately 375 mds. The actual weight of this volume of silage may be more if put in quite green or less if somewhat dry. A moderately good stand of *jowar* will give at least 6 tons of fresh green fodder to the acre and more often 10 tons or more. Quite good *jowar* such as is commonly grown in the more fertile fields near the village site will easily fill a silo, much as suggested above, from about one acre. A cultivator having four animals to feed will usually have this much fodder In addition to the *jowar* which may be available, *bajra*, grasses or other substances may be used.

An objection may be made that this contemplates putting nearly the whole crop of fodder into the silo and that the silage contemplated would only feed the animals part of the year. On the minimum calculation of 2 in. of silage or 100 lb. per day and 45 ft. total depth of silage, there would be silage for 9 months or 270 days. In an experimental trial at the Agricultural Institute, Allahabad, in 1943, two pairs of animals were fed from the middle of July till the beginning of December with roughage consisting entirely of grass and weeds cut from the fields and *bunds*. This can be easily supplemented by thinnings and some *bhusa*, or other material gathered from the fields, or from crops such as legumes harvested during this period. It appears, therefore, that even small holdings of 5 to 7 acres can provide the silage material for silos of a minimum diameter of 5 ft. and a combined depth of 45 ft. which will feed four animals for 270 days, and that for the remaining three months of the year other fodders can be used. This assumes that little or no rough fodder is sold from the land.

## Problem of chaffing

It seems, therefore, that the silo is not difficult to provide over large parts of India and that the fodder is available even on fairly small holdings. The other

difficulty, perhaps the major one, is that of a chaff cutter. Experience so far does not seem to indicate the practicability of filling even small silos by hand-cutting. Bullock-driven cutters may be practicable, but are not available at present. The smaller imported power driven cutters, such as are used in considerable numbers by *gowalas* in the cities, are suitable but are too expensive for individual ownership in the villages. Before the war, such cutters were available at prices ranging from Rs. 250 to 500. These required from 3 to 6 H. P. (horse power) to drive them. In villages where the hydro-electric grid system makes current available, electric motors of these sizes are practicable and are available at a cost of about Rs. 50 per horse-power. Small oil engines to work on kerosene were available at Rs. 100 per H. P. and diesel engines at Rs. 150 per H. P. in sizes of 5 to 6 H. P. Very little is known about the working costs of such small chaff cutter installations. It is known that *gowalas* having 20 cows or buffaloes to feed have found it economical to install such small power-driven cutters. The author does not know of any engine-driven cutters of this sort owned by *gowalas*, but there is no inherent difficulty in the installation beyond the capital cost and the mechanical skill required to work it. Such an outfit can be easily made portable and should be able, if 5 to 6 H. P. is provided, to fill two such silos in a week or 10 days The silage cutting season ordinarily extends over a period of two to three months if grain is not taken from at least part of the fodder, or even over five to six months if some irrigated fodder is grown. It seems that the operation of such an outfit might well be a profitable business for a mechanically minded young man able to invest Rs. 1,500 to Rs. 2,000. As the seasons do not conflict, the same engine might be used with a small power-driven cane crusher or possibly also with a small pump for use in the winter. Other jobs might be found for it. It seems that experimentation with such outfits might well be encouraged by those interested in introducing silage. The lack of means of chaffing the fodder seems to be the main limiting factor in introducing silos in the villages.

## Allahabad experiment

The Agricultural Institute at Allahabad has made two small silos each 6 ft. in diameter and about 30 ft. deep. These are being filled with a small engine-driven cutter and the silage will be fed to four to six cows used for the cultivation of a rain-fed experimental farm of 40 acres. The fodder being put in these silos has had most of the grain removed and is drier than is desirable for the best silage. The filling outfit is improvised and not entirely suitable. It is proposed to carry on the experiment for some years to determine costs and results. Development work is also in hand on a bullock-driven chaff cutter, but these experiments are being hampered by war-time shortages of material and staff. Results will be published from time to time. The author will be glad to hear of similar experiments elsewhere.

---

"Soil conservation is not the private concern of any one nation nor of any one group of people. Soil conservation is the concern of all nations, and of every citizen in every country. The future of all nations, in the last analysis, depends on how we use and care for the croplands of the word......"—*Agricultural Missions Notes.*

difficulty, perhaps the major one, is that of a chaff cutter. Experience so far does not seem to indicate the practicability of filling even small silos by hand-cutting. Bullock-driven cutters may be practicable, but are not available at present. The smaller imported power driven cutters, such as are used in considerable numbers by *gowalas* in the cities, are suitable but are too expensive for individual ownership in the villages. Before the war, such cutters were available at prices ranging from Rs. 250 to 500. These required from 3 to 6 H. P. (horse power) to drive them. In villages where the hydro-electric grid system makes current available, electric motors of these sizes are practicable and are available at a cost of about Rs. 50 per horse-power. Small oil engines to work on kerosene were available at Rs. 100 per H. P. and diesel engines at Rs. 150 per H. P. in sizes of 5 to 6 H. P. Very little is known about the working costs of such small chaff cutter installations. It is known that *gowalas* having 20 cows or buffaloes to feed have found it economical to install such small power-driven cutters. The author does not know of any engine-driven cutters of this sort owned by *gowalas*, but there is no inherent difficulty in the installation beyond the capital cost and the mechanical skill required to work it. Such an outfit can be easily made portable and should be able, if 5 to 6 H. P. is provided, to fill two such silos in a week or 10 days The silage cutting season ordinarily extends over a period of two to three months if grain is not taken from at least part of the fodder, or even over five to six months if some irrigated fodder is grown. It seems that the operation of such an outfit might well be a profitable business for a mechanically minded young man able to invest Rs. 1,500 to Rs. 2,000. As the seasons do not conflict, the same engine might be used with a small power-driven cane crusher or possibly also with a small pump for use in the winter. Other jobs might be found for it. It seems that experimentation with such outfits might well be encouraged by those interested in introducing silage. The lack of means of chaffing the fodder seems to be the main limiting factor in introducing silos in the villages.

## Allahabad experiment

The Agricultural Institute at Allahabad has made two small silos each 6 ft. in diameter and about 30 ft. deep. These are being filled with a small engine-driven cutter and the silage will be fed to four to six cows used for the cultivation of a rain-fed experimental farm of 40 acres. The fodder being put in these silos has had most of the grain removed and is drier than is desirable for the best silage. The filling outfit is improvised and not entirely suitable. It is proposed to carry on the experiment for some years to determine costs and results. Development work is also in hand on a bullock-driven chaff cutter, but these experiments are being hampered by war-time shortages of material and staff. Results will be published from time to time. The author will be glad to hear of similar experiments elsewhere.

---

"Soil conservation is not the private concern of any one nation nor of any one group of people. Soil conservation is the concern of all nations, and of every citizen in every country. The future of all nations, in the last analysis, depends on how we use and care for the croplands of the word......"—*Agricultural Missions Notes.*

# MANURES AND MANURING*

## Chapter VI

### FARM PRACTICE WITH FARM MANURES

*By*

SUDHIR CHOWDHURY

In considering the plant-food value of farm manures one has to keep in mind that it is an essential product of the farm, and that it must constitute the main source of manure for the land under the condition of ordinary mixed farming where special manures will only be used as supplements and not as rivals. As a fertilizer, the chief value of farm manures lies in the fact that it contains all the elements of a plant's nutrition—nitrogen, phosphoric acid, and potash,—though for a well-balanced manure the phosphoric acid is comparatively deficient. Moreover, the nitrogen is present in various forms of combination, varying from the rapidly acting ammonia compounds down to some of the undigested residues which will remain for a long time in the soil before becoming available to the plant. In consequence farm manure is a lasting manure which accumulates in the soil to build up what a farmer calls 'high condition.' As mixed farm manure contains on the average 0·50 per cent. of nitrogen, 0·25 per cent. of phosphoric acid and 0·60 per cent of potash considerable quantities of plant food elements are added in an ordinary application.

The value of farm manures to the land is by no means confined to its fertilizing action, its physical effects upon the structure of the soil are equally important. In the first place, manure as it rots down produces humus. This humus increases the absorptive capacity of the soil. In clay it promotes granulation, while in sands it acts as a binding agent. Under all conditions it promotes granulation and improves tilth. The capacity of a soil to resist drought is raised, its aeration is increased and drainage is promoted. All these changes tend to benefit plant growth.

From the chemical standpoint, the presence of farm manures in the soil tends to increase organic acids, notably carbonic acid. The soil minerals are thus rendered more easily soluble. The humus may also combine with certain of the mineral elements and hold them in a form more easily available to crops. Nor is the chemical influence of farm manures the final effect. The modification of the soil flora can by no means be passed by. Not only are millions of organisms added by an application of manure, but those already present in the soil are vastly stimulated by this fresh acquisition of humic materials. Nitrification, ammonification and nitrogen-fixation are also increased to a remarkable extent.

**Application of Farm Manures:**

The old-fashioned and well-known maxim 'too much of a good thing is bad,' true of so many processes, associated with agriculture, is no less true with regard to the application of farm manure. The best results have been found by experiment to be got from comparatively light uniform applications rather than from extremely heavy ones, and more of the beneficial ingredients of the dung in proportion to be used by the plants. It used to be quite a common practice to apply anything from 15 to 30 tons per acre once in a five or six year rotation, with none in between. This, of course, is obviously bad practice and experience and research in more recent years have shown that 2 to 10 tons per acre, supplemented by suitable combination of special manures, depending of course on the

*Continued from previous articles which have appeared in the Allahabad Farmer.

quality of the manure, the soil, and the particular crop, applied each third or fourth year when conditions are suitable, are ample and to be preferred.

On light sandy soils, it is advantageous to apply well-rotted manure rather than that only partly decomposed, and it is well to apply it just before the crop is sown. The reason is that the short straws and fibres of well-decayed manure tend to firm up these open soils, whereas the long undecomposed fibre in fresh manure tends rather to open up a soil. Further, if the manure is put down too long before the plant is able to avail itself of the soluble matters, then they tend in these soils to get rapidly washed down out of reach by heavy rains.

In heavy soils, clay or otherwise, on the other hand, it is far better to apply much fresher dung, a considerable time before the crops need its substance. The undecomposed long straw open up these stiff soils, loosen them, and so aerate them, and help to drain them ; decomposition of the manure takes place actually in the soil, having its effect on the organic, and also on the mineral constituents of the soil themselves, and so effecting a change in them from a dormant to an active condition.

## Distribution of Farm Manures in the Field :

In the actual application of farm manures to the land, certain general principles should always be kept in mind. In the first place, evenness of distribution is to be desired, since it tends to raise the efficiency of the manure by encouraging a more uniform plant growth. This evenness of spreading is much aided by fineness of division. Moreover, it is generally better, especially in diversified farming on medium to heavy soils, to decrease the amounts at each spreading and apply oftener. Thus instead of adding 20 tons to the acre, 10 tons would be applied and twice as much area covered. The applications would then be made often. A larger and quicker return in net crop yield per ton of manure applied would be realised. This has been strikingly shown by the Ohio experiments over a test for eighteen years in a three-years' rotation of wheat, clover and potatoes, the manure being placed on the wheat and affecting the clover and the potatoes as a residum. The results are expressed below in yield per ton of manure applied.

| | Wheat (Bushels) | Clover (Bushels) | Potatoes (Bushels) |
|---|---|---|---|
| 4 tons to the acre | 8·0 | 177 | 37.3 |
| 8 tons to the acre | 4·1 | 150 | 19.3 |
| 16 tons to the acre | 2·4 | 99 | 11.6 |

Not only is the increased efficiency from lower applications apparent, but a great recovery of the manurial fertility in the crops also results. The Ohio experiments have shown that in the first rotation after the manure is applied, a recovery may be expected from a treatment of 8 tons 25 to 30 per cent higher than from one of 16 tons.

Evenness of application and fineness of division are greatly facilitated by the use of a manure spreader. It is impossible to spread manure by hand and obtain an even distribution. Moreover, a spreader lessens the labour and more than doubles the amount of manure one man can apply a day.

Whether manure should be ploughed under or not depends largely on the crop on which it is used. Ordinarily, however, it is ploughed under. This is particularly necessary if the manure is long, coarse and not well rotted. It should not be turned under so deep, however, as to prevent decay. If manure is fine and well decomposed, it may be harrowed into the surface soil. The method employed depends on the crop, the soil and the condition of the manure.

## The Time to Spread Farm Manures on Fields:

If on any account partially fermented manure must be allowed to lie on the surface of fields for sometime before it can be incorporated with the soil, its application should preferably take place just prior to or during fall of rain, in order that the ammonium carbonate may be carried directly into the soil, for the soil readily absorbs and holds ammonia excepting under conditions not commonly met with in agricultural practice.

## Importance of Tillage as Related to Manuring:

No matter how carefully the manures are handled and applied, full results cannot be secured unless superior tillage is practised. The facts previously stated show that many, if not most arable soils contain vast quantities of potential plant-food, and that the yield of crops raised on them indicates that but a very small fraction of this plant-food is available for the production of any single crop. Jethro Tull and recently others have proved that tillage may be made the great factor in increasing productivity; and it has also been proved that it is not economical to neglect tillage and seek to produce maximum crops by the application of large quantities of manures.

## Residual Effect of Farm Manures:

The residual effects of farm manures in the soil are of long duration, as the Rothamsted experiments have fully demonstrated. In this connection Hall of the Rothamsted gives the results on grass where stable manure was applied at the rate of 14 tons per acre per annum for 8 successive years (1856—1863), the land then being left in grass without manure for 40 years. These results are compared with those secured on a similar field to which no manure was applied. The greatest increase over the unmanured area was in 1865, two years after the last application was made. The gain in that year amounted to 120 per cent. In the decade from 1866 to 1875 and for the three decades thereafter, the average increase in the produce due to previous applications of manure was 57, 24, 6 and 15 per cent respectively.

## Farm Manures Profitably Supplemented by Special Manures:

Where farm manure commands a high price or where the cost of hauling is great, it is usually better economy to employ only moderate amounts and to supplement it with special manures, than to place entire dependence upon it. This is well shown by experiments at Rothamsted in which the use of 200 lbs. of nitrogen in stable manure resulted in a yield of but 27.2 tons of mangel wurzels, as compared with a yield of 33 tons where but 86 lbs. of nitrogen were employed in nitrate of soda, which was properly supplemented with potash and phosphoric acid. The farm manure used with the same amount of nitrate of soda gave a yield of 41.4 tons and when further supplemented by potash and phosphoric acid, the yield was only increased about 0.1 ton.

## Farm Manures Compared with Special Manures:

It is not uncommon to see farm manures compared with special manures on the basis of their respective content of nitrogen, phosphoric acid and potash. Such comparison is not believed to be a correct basis for determining relative value, since farm manure serves certain purposes that special manures cannot serve. Farm manures are of very complex composition. They contain more or less all the elements contained in the food given to the animals and in the litter. They are rich in organic matter, being composed chiefly of vegetable substances. This organic matter is a source of humus in the soil and may be of much value.

Those elements of plant food that are found in manures, and which are not ordinarily deficient in soils, as lime, magnesia, and sulphur, are not without their value ; yet it has been customary to value manures on the basis of the nitrogen, phosphoric acid and potash they contain. True their value is determined chiefly by the proportions of these elements but the secondary elements are also of value. Soils, moreover, need humus. Farm manures supply this. Special manures do not, and when the effort is made to keep the land in good productive condition without the use of farm manures, it is commonly essential to adopt special measures for the production of humus, as by the occasional introduction of green-manuring crops, or occasionally putting the land fallow. It is true the plant food elements in special manures are often somewhat more promptly available than in farm manures; but while this in itself is an advantage it is also a danger, for the chances of loss are thereby increased. With skilful use the probability of loss of plant food elements applied in special manures is greatly reduced, and there is considerable experimental evidence to show that a given quantity of nitrogen in the form of some of the best nitrogenous manures, such as nitrate of soda, will increase crops to a greater degree than the same quantity of nitrogen in farm manures. Nevertheless the latter appear to give to arable soils certain qualities which can scarcely be secured except by their use, and it will be generally conceded by those qualified to judge that farm manures are sometimes worth more to the farmer and gardener than the figure obtained by estimating at usual trade values the nitrogen phosphoric acid and potash they contain.

## Place of Manure in the Rotation :

With a number of trucking crops, the application of manure directly to the crop year after year has proved to be advisable. In an ordinary rotation, however, where less intensive methods are employed, it is evident that manure may vary in its effect according to the place in the rotation at which it is applied. This has proved to be the case with special manures and the fact is also becoming recognised in the economic use of farm manures.

In general, hay has derived more benefit from the residual food than almost any other crop in the rotation. At the Pennsylvania Experiment Station, in a rotation of corn, wheat and hay over a test for twenty-five years in which manure was applied in equal amounts to the corn and wheat, the results were as follows :

*Percentage Increase from Use of Manure and Value of that Increase.*

| Treatment | Corn | Oats | Wheat | Hay |
|---|---|---|---|---|
| 6 tons manure ... | 37 % | 28 % | 73 % | 39 % |
| Cost $/9 ... ... | 10.85 | 3.66 | 9.70 | 6.55 |

The same fact has been clearly shown in the Ohio experiments covering a term of eighteen years. The query immediately arising here is : If hay responds so well to residual feeding why not apply the manure directly to it? On this point the following figures from the Illinois Experiment Station may be presented, comparing the response of corn and oats when manured to the yield of clover with the same treatment :

| Treatment | Average percentage increase | | Total value of increase | |
|---|---|---|---|---|
| | Corn & Oats | Clover | Corn & Oats | Clover |
| Manure ... | 11 | 92 | $ /7·53 | $ /10·08 |
| Manure, lime and phosphate ... | 30 | 141 | 12·21 | 15·48 |

When hay is included in any rotation it is evident that the best results from manure may be obtained by placing it on this crop. This, however, is often not advisable, especially where the amount of manure is limited.

### Commercial and Agricultural Evaluation of Farm Manures :

What price should be set upon a ton of farm manure is a question often asked but no general answer is possible, so much depends upon the other conditions prevailing upon the farm. As a rule farm yard manure is part of the normal output of the farm ; the farmer has only to make it and use it to the best advantage, he is not concerned with the question of whether it would be cheaper to replace it with an equivalent amount of some other manure. There are, however, occasions when the problem does arise of whether it is cheaper to make farm manure, to buy it or to attempt to replace it by some special manures. It is important, therefore, to try and put some monetary value to it, so that the farmer may attain a clearer idea of the procedure to follow. It is, of course, possible to treat farm manures like any other special manures and value it on the unit system, the result of which would be somewhat as follows. The value of the nitrogen is here placed at ten cents a pound, the phosphoric acid at two and one-half cents and the potash at four cents :

| | Value of Manure a ton |
|---|---|
| Swine Manure | $ 1.50 |
| Cow Manure | 1.64 |
| Horse Manure | 1.97 |
| Sheep Manure | 2.87 |
| Poultry Manure | 4.80 |
| Average of Cow and Horse Manure Mixed | 1.80 |

Much weight cannot, however, be attached to such a valuation because the unit values are taken from special manures and do not apply to dung. In such valuation the organic matter supplied in the farm manure is not valued ; yet it is for the effect of this organic matter on the structure of the soil that farm manure is most generally required. The agricultural value of the farm manures is, therefore, more than its commercial value. The latter is based on composition while the former arises from the effects as measured in crop growth. A manure of high commercial value, may, when placed in the soil, yield only a low to medium agricultural return. This latter valuation is of course the one of greatest significance in agricultural practice. A very good example of this might be cited from the Ohio experiments with manure. In this case both treated and untreated manure were evaluated commercially and were then applied to the land. The value of the increased crops in a three-year's rotation was then calculated in terms of return to a ton of manure applied :

*Commercial and Agricultural Evaluation of Manures.*

| Treatments | Commercial value | Agricultural value |
|---|---|---|
| Yard Manure untreated | $1.41 | $2.15 |
| Yard Manure plus floats | 2.04 | 3.31 |
| Yard Manure plus acid phosphate | 1.65 | 3.67 |
| Yard Manure plus Kainit | 1.45 | 2.79 |
| Yard Manure plus gypsum | 1.48 | 2.76 |

In practice, then, it is this agricultural evaluation which must be especially watched. Its expression should be not only in net yield to the acre, but also in net return to a ton of manure applied.

## References


| | |
|---|---|
| Agee, Alva | Crops and Methods for Soil Improvement. |
| Aikman, C.M. | Manures and Manuring. |
| Hall, A.D. | Fertilizers and Manures. |
| Lyon, T.L. and others | Soils : Their Properties and Management. |
| Miller, C.E. | Soils and Soil Management. |
| Miller, M.F. | The Soil and Its Management. |
| Mosier, J.G. | Soils and Crops. |
| Thorne, C.E. | Farm Manures. |
| Wheeler, J.H. | Manures and Fertilizers. |
| Worthen, E.L. | Farm Soils : Their Management and Fertilization. |

Manures and Manuring. Lond. Min. Agri. Fish. Bul. 36

General Fertilizer Expts. Annual Report. Penn. Agri. Exp. Sta. (1907-08)

Plans and Summary Tables of the Experiments at the Central Farm Ohio. Expt. Sta. Circ. 120.

Thirty Years of Crop Rotation in Illionis. Ill. Agri. Exp. Sta. Bul. 125

Care, Use and Economic Value of Farm Manure Oreg. Exp. Sta Circ. 105.

Getting the Most Profit from Farm Manure. Wis. Exp. Sta. Bul. 221.

Production, Care and Use of Farm Manure. Ky. Exp. Sta Circ. 155.

The Value of Barnyard Manure on Utah Soils. Utah Exp. Sta. Bul. 172.

What is the value of a Ton of Farm Manure. Md. Exp. Sta. Bul. 266.

The availability of Nitrogen in Farm Manure under Field Conditions. Soil Sci. 31 ; 467-481.

The Value of Manure on Indiana Soils. Ind. Exp. Sta. Bul. 2[illegible]2.

Value and Care of Farm Manure. Mich. Exp. Sta. Ext. Bul. 71.


---

Poverty anywhere is a threat to prosperity and civilization everywhere.

—*Frances Perkins.*

# THE EFFECT OF DIFFERENT PHOTO PERIODS ON THE GROWTH OF SOLANUM TUBEROSUM.

By

S. R. Barooah, B.Sc. (Ag.), M. Sc. (Ag. Bot)., Agronomy Department,
*Allahabad Agricultural Institute.*

## INTRODUCTION

The amount of literature available on plant photoperiod relationship shows that a good amount of work has been done in connection with it during the course of the last twenty years. This certainly shows the great conomic significance of this variable in the cultivation of plants. Much of the work seems to have been directed on field crops where the yield of grain is important. But there are plants in nature where either foliage or reproductive system does not have much practical importance, and where the product of synthesis is translocated to under-ground parts, the so-called organs of storage. Light, which is the mainstay of living organisms and which is a great contributing factor in the process of plant assimilation must have a great deal of influence on the product of storage and the process of translocation. Certainly, a few contributions have been made by such workers as Garner (1923), McCleland (1928), Wilson (1932), and Roy Magruder and Allard (1927) in this direction, even on plants which form the material of the present investigation. But since these investigations have been conducted only in regions far different from those of ours; and since the classification of plants and their characteristic response so often cited by Garner and his associates have been recently pointed out by Singh et al to bear no universal significance; it was considered useful to determine plant photoperiod relationship in case of plants such as Solanum tuberosum and Allium cepa (the report of our investigation on this will be made at a later date.)

## EXPERIMENTAL PROCEDURE

*Solanum tuberosum.* L. (var. Darjeeling) was chosen as the appropriate material for experimentation. The potato tubers, which were fairly big in size, were cut into small pieces containing three "eyes." The pieces were made as far as possible of uniform weight, which was done first by approximation, then later on by the use of a physical balance. The average weight of pieces maintained was $8 \pm 0{\cdot}02$ gms. Six such seed potato pieces were planted in each pot to a depth of about 2″ to 3″ and then they were covered with soil.

The seeds sprouted 16 days after sowing. Twenty days after sprouting the plants were thinned to two plants only in a pot. The pots were then transferred to different places where the arrangements for exposure to different light periods were arranged.

The length of exposure used were zero, six, normal (average 11 hours 5 mins.), eighteen, and twenty-four hours, and were obtained either by the addition or substraction from the normal daily duration. The long duration plants were treated with light from 500 Watt Mada lamps fitted in polished reflectors. The control set was exposed to the ordinary day light. The short duration sets were exposed to the day light according to their respective requirements and the rest of the period they were kept in the dark room which was absolutely light proof.

Difference among plants subjected to differing conditions of factor intensity often appearing big may be devoid of real significance. In order thus to judge the validity of morphological variations occurring among different sets of plants exposed to different conditions of illumination, a statistical interpretation was deemed essential. Observations were tabulated and the standard deviation was computed, as this helps to understand the significance of the variations observed.

## EXPERIMENTAL RESULTS.

*Shoot growth.*—The elongation of the shoot in case of Solanum at different photoperiods is marked by several interesting features. In a normal duration lot

elongation of the shoot was rapid, later on less, and ultimately there was noted decreased in length. This is explicable on the fact that at maturity due to shrinking off of tissue there is usual reduction in size of all normally growing shoots of annual plants.

A far rapid pace in the matter of shoot elongation was surprisingly noted in the first two weeks of growth in plants grown both under short and long duration illumination. Plants grown under 6 hours duration probably exhibited this phenomenon of rapid elongation in the search of more light because the light supply to these plants was obviously far too deficient ; while long duration lots in view of excessive light condition exhibit profuse vegetative growth. Thesefeatures of plants are further clarified on the observation that the plants of the short duration lots, are weak and attenuated as there was continued elongation until February 1st, and after which they died. Long duration sets on the contrary continued elongation until the end of the life cycle of the plants attaining more than double the size in case of 18 hours lot and more than three times in continously illuminated one (Table 1 and fig. 1). Such observations are in close co-ordinations with the findings of

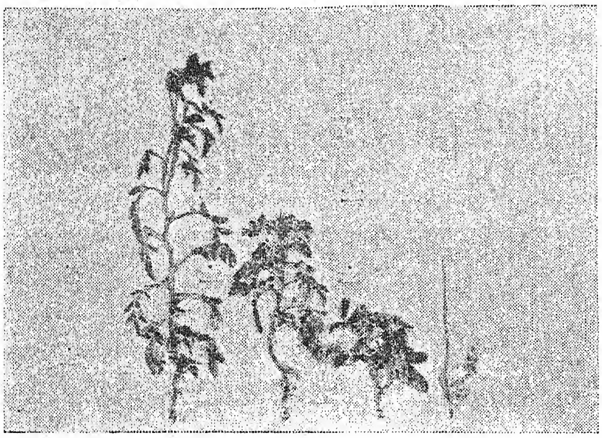


FIG. I

Effect of different photo-periods on the shoot growth of potato.

1. Plants under 6 hrs. photo-period.
2. ,, ,, normal hrs. photo-period.
3. ,, ,, 18 hrs. ,, ,,
4. ,, ,, 24 hrs. ,, ,,

TABLE I.

*Stem height (cm.)*

| Date of obeservation. | Age in days. | Photoperiods. | | | | |
|---|---|---|---|---|---|---|
| | | Short | | Normal | Long | |
| | | 0 hrs. | 6 hrs. | | 18 hrs. | 24 hrs. |
| December 15 | 41 | 9·00 →0·12 | 9.00 ±0·12 | 9·00 ±0·12 | 9·00 ±0·12 | 9·00 ±0·12 |
| January 1 | 56 | plants died | 21·00 ±0·24 | 14·00 ±0·17 | 19·00 ±0·18 | 20·00 ±0·21 |
| January 15 | 71 | ,, | 22·00 ±0·24 | 16·00 ±0·19 | 20·00 ±0·22 | 25·00 ±0·26 |
| February 1 | 86 | ,, | 24·00 ±0.46 | 17·00 ±0·26 | 24·00 ±0·52 | 30·00 ±0·31 |

TABLE I (*Contd.*)

| Date of observation. | Age in days. | Photoperiod Shorts. 0 hrs. | Photoperiod Shorts. 6 hrs. | Photoperiod Normal. | Photoperiod Long. 18 hrs. | Photoperiod Long. 24 hrs. |
|---|---|---|---|---|---|---|
| February 15 | 101 | ,, | plants died | 18·00 ±0 52 | 26·00 ±0·46 | 36·00 ±0·36 |
| March 1 | 116 | ,, | ,, | 18·00 ±0·46 | 36·00 ±0·36 | 53·00 ±0·76 |
| March 15 | 131 | ,, | ,, | 14·00 ±0·24 | 38·00 ±0·78 | 54·00 ±0·86 |
| March 25 | 141 | ,, | ,, | 10·00 ±0·19 | 39·00 ±0·36 | 56·00 ±0·97 |

Garner and Allard (1920, 1923) and Singh, et al. (1938) who indicated that, under continuous illumination, plants often grow purely vegetatively leading to the phenomenon of gigantism.

*Branching behaviour.*—At the age of 41 days there was no difference in the number of branches because hardly any time elapsed since the plants began to be exposed to differing conditions of light. In weeks following, however, difference appeared from set to set in this respect. Branches in the control set increased in number for some months until February 1st and after that there was a decrease (Table II). This was obviously a drying effect on these plants.

TABLE II.

*Number of branches per plant.*

| Date of observation. | Age in days. | Photoperiod Shorts. 0 hrs. | Photoperiod Shorts. 6 hrs. | Photoperiod Normal | Photoperiod Long. 18 hrs. | Photoperiod Long. 24 hrs. |
|---|---|---|---|---|---|---|
| December 15 | 41 | 10 ±0·22 | 10 ±0 22 | 10 ±0·22 | 10 ±0·22 | 10 ±0·22 |
| January 1 | 56 | Plants died | 14 ±0·27 | 10 ±0·24 | 14 ±0·25 | 25 ±0·26 |
| January 15 | 71 | ,, | 14 ±0·25 | 11 ±0·26 | 14 ±0·27 | 17 ±0·28 |
| February 1 | 86 | ,, | 20 ±0·22 | 14 ±0·28 | 16 ±0·29 | 17 ±0·28 |

TABLE II (*Contd.*)

| Date of observation. | Age in days. | Photoperiod | | | | |
|---|---|---|---|---|---|---|
| | | Shorts. | | Normal. | Long. | |
| | | 0 hrs. | 6 hrs. | | 18 hrs. | 24 hrs. |
| February 15 | 101 | ,, | Plants died | 10 ±0·17 | 16 ±0·19 | 19 0·21 |
| March 1 | 116 | ,, | ,, | 9 ±0·16 | 16 ±0 21 | 22 ±0·24 |
| March 15 | 131 | ,, | ,, | 8 ±0·14 | 14 ±0·16 | 18 ±0.17 |
| March 25 | 141 | ,, | ,, | 7 ±0·13 | 10 ±0·17 | 18 ±0·19 |

In the unilluminated set the question of branching did not arise because the plants died at quite an early stage of life. In the other short duration lot the number of branches progressively increased depicting a shade loving nature. When often the vegetative developments of plants increased even on short days this duration of illumination was, however, apparently insufficient for the later well developed plants which often could not survive after February 1st. The long duration set again showed a progressive increase above the level of controls for several successive months in this regard while, later, the number of branches in long duration series in respect to normal plants was certainly due to greater facility made possible for photosynthetic activity by the increase in supply of light in these two sets. The photograph (Fig II) also clearly depicts the branching behaviour of the plants as affected by different photoperiods.

*Root ramification*—Lateral and vertical development of roots is also greatly modified by different photoperiods (Fig. II). These observations are in close accord with those of some other workers, as Weaver and Himmel (1929), and Zimmerman and Hitchcock (1929), who also reported that length of day markedly effects the type of root system.

The root development showed a direct relationship with the increase in the photoperiods. The plants under the normal photoperiod had very little root development and less number of finer roots. Under the short photoperiod the root development was still poor, where only a few roots developed with little ramification. But under the longer photoperiods the root development increased. The 18 hours set showed the development of longer and many finer roots. The plants of the continuous illumination set showed the heaviest root growth with

thick long and many fiberous roots attached to the long roots. The fibrous roots were very fine and emerged from practically throughout the big roots (Fig. II).

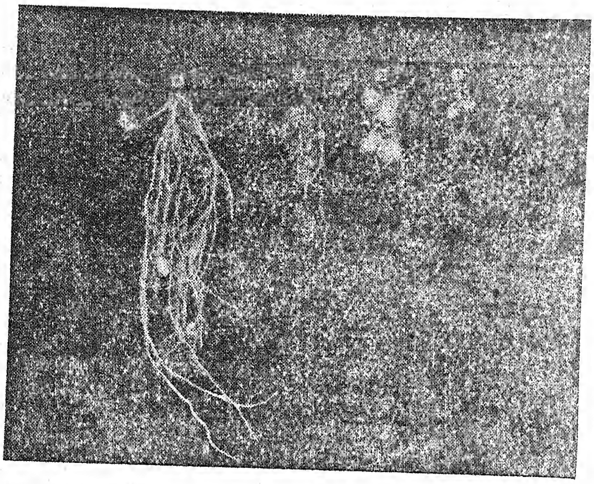


Fig. II

Effect of different Photo periods on the root growth and tuber production of potato.

1. Plants under 6 hrs. photo-period.
2. " " normal hrs. photo-period.
3. " " " " "
4. " " " " "

This is rather interesting to note that plant organs which are developed under ground and devoid of chlorophyll indicating little relationship with light conditions of atmosphere are so greatly attuned with fluctuations in this factor.

*Morphological differences in tubers*—In Solanum the underground portions which are known as tubers are the most economically important organs of the crop. The food matter is manufactured in the leaves with the help of light and chlorophyll; and this food matter is translocated to these underground forms where it is stored. As light affects the manufacture of food products by changing the machinery of the food production, so it must affect the growth and the development of the storage parts where the food is finally stored. Hence, to find out the effect of the duration of light on the storage parts the morphology of tubers was critically examined. The results obtained here show a similarity to the results obtained by McCleland (1928), Wilson (1932) and Roy Magruder and Allard (1937) who have found that in America short photoperiods favoured tuber formation.

*Number of tubers*—The potato plants when exposed to the normal photoperiod showed a vigorous growth of tubers. The plants as they received the normal daily illumination, *i. e.* their regular requirement, showed a rapid increase in their number of tubers, but later on the increase in the number was not so marked; and in the later phase of growth the number practically remained constant. This phenomenon took place probably because of the stunted growth of the leaves after a period of growth, which are the machinery of food production.

The plants exposed to both short and longer periods of illumination showed a very striking difference in the formation of number of tubers as compared to the plants exposed to the normal photoperiod (Cf. Fig. II). That atmospheric factors like light ordinarily thought to be unconcerned with the development of underground organs are of quite great significance is clear from the marked difference obtained in tuber production by a sheer change in the atmospheric conditions of light. The plants under short photoperiod demonstrated a very poor growth in the number of tubers which practically remained the same throughout the life cycle. It happened because of want of light and the less number of leaves produced by the plants which is the tool for the manufacture of food production—thus affecting tuber production. The plants under longer photoperiods also showed very little production of tubers which remained constant during the later part of the growth cycle. This was due to the excessive growth of the foliage which utilized all the materials that were manufactured and very little amount was translocated to the under-ground portions for tuber production.

The photograph clearly indicates the maximum production of tubers under normal photoperiod, and then decrease in number as the photoperiod increased or decreased.

## DISCUSSION.

The aim in view while conducting the investigation was to find out the effect of the lentgh of day on Solanum tuberosum L. with special reference to the production of the underground forms in relation to the various growth and developmental characteristics. Various anomalies in all aspects of plant were noticed in various experimental plants grown under different photoperiods. It was seen that these anomalies in the same species grown under different day length was, however, to some extent perplexing.

The vegetative growth of the crop is effected very much by the different photoperiods to which they are exposed. The shorter photoperiods inhibit shoot growth, but the longer photoperiods activate the shoot growth showing a gigantic nature. The production of tuber is favoured more by the normal photoperiod than either by the longer or the shorter ones (c. f. Garner, 1923; Wilson 1932). The root growth which also forms a part of the morphology of the plant is affected to a great extent by a different photoperiod. The root growth is very poor under the short photoperiods whereas longer photoperiods activate profuse root growth, the activation being very pronounced under the 24 hours set (c. f. Zimmerman and Hitchcock 1929 ; and Weaver and Himmel, 1929).

Huxley (1932), Glass (1933), Thimann (1934), Ramshorn (1934), Avery (1935), Snow (1935), Cazlachjan (1936), in this field have found that growth and development in plant are largely controlled by various growth regulating substances. It may be suggested that different photoperiods associate differential production of these substance which, in turn, bring about differential growth and developmental manifestations. It seems that the production of growth promoting substances vary with different types of plants also. It is probably due to this effect that in potato short photoperiod is characterised by poor shoot growth, while long photoperiod results in the gigantic shoot growth.

Though plants when they are exposed to the different photoperiods show a differential effect on the various parts of the plants, it is clear from the observation that the plant as a whole has a definite relationship to different photoperiods and the growth, and development of the plant is affected by the different photoperiods. It was thought that differential growth and developmental characters depend solely upon the genetic constitution of the plant material, but this investigation and the investigations carried out by others (Garner and Allard, 1920, 1923, 1925 ; Wilson 1932 ; Roy Magruder and Allard, 1937, etc) definitely show that atmospheric light condition, specially different photoperiods, has a profound effect on the growth and development even of the underground parts, which indicate that though they are not directly connected still the indirect effect is of very great importance.

## SUMMARY AND CONCLUSION.

The present investigation deals with the response of the under-ground stems represented by Solanum tuberosum (var. Darjeeling) under non-limiting conditions of environment to different photoperiods such as continuous darkness, 6 hours, normal (average 11 hours 6 minutes), 18 and 24 hours daily illumination. The longer photoperiods were supplemented by artificial light to normal day length.

The longer photoperiods favour shoot growth producing a phenomenon of gigantism by the continously illuminated set, but the short produce a very poor shoot growth which dies before proper development.

The root ramification and development increase with the increase of the photoperiods, the maximum being under the continously illuminated set.

The tuber production is more pronounced under the normal photoperiod, whereas both the short and the long photoperiod produce very poor tubers with abnormalities.

In conclusion the writer wishes to express his indebtedness to Dr. R S. Choudhury of the Institute of Agricultral Research, Benares, for his advice and encouragement during the process of experimentation and to Prof. Sri Ranjan, D. Sc., of the Allahabad University, and to Prof. B. M. Pugh of the Agricultural Institute, Allahabad, for their encouragement to complete the writing of the paper.

## HOME ECONOMICS

By

Miss Pramila Pandit, B. A.

*Student of Home Economics, Allahabad Agricultural Institute*

The term "Home Economics" is generally misunderstood. It is not merely teaching a girl how to cook, to sew or to keep her house clean, but it also teaches one how to administer homes wisely. It is a job which requires as much knowledge as any other profession.

"Home Economics" is a new branch of knowledge. America, a place which is much more developed, advanced and better off than our India, is finding this course so very important and needful for the girls that it is flourishing in Universities. This course is about 100 years old there. From this we can realize how far behind we are in India and, therefore, the necessity for young women to study Home Economics.

Home Economics was first thought of by Mary Lyon of America in 1837. Girl students were that year alloted certain domestic duties, although no formal education in the subject was as yet given. In 1865 certain lectures and demonstrations were given on Domestic Economy, but that lasted for only 3 years. Thus courses in cooking, house keeping, sewing, dressmaking, etc., were taken up and then dropped, due to some reason or other. It was not till the last quarter of the 19th century that formal instruction in Home Eonomics was begun and series of lectures were given. It is now a very popular course and a majority of girls take it and are enthusiastic about it. To-day in America there are about 500 colleges and Universities offering Home Economics, and there are about 45,000 girls who are studying this subject. On the contrary, in India there are only a few institutions of this kind imparting knowledge to only a handful of girls. Women of this country are hardly aware of it or know its importance. While household arts have always been considered a part of a girl's training, yet to give it as a part of a college education is a new idea in this country. Here, at the Allahabad Agricultural Institute, one has been able to get only a partial picture of the whole course of Home Economics. But I am sure, in time to come, a complete course will be opened where one could acquire specific knowledge on one particular branch of House Economics. Girls from all over India will be given the knowledge regarding art, child development, foods and nutrition, home management, household equipment, textiles and clothing, and physical education.

In the Home Economics course at Allahabad a training in Home Economics is given together with such foundation studies as English and social, physical and biological sciences. A young girl should look forward to getting this type of training. It is a great thing to bring the knowledge of many sciences together for better home living. In other schools we train our minds only, but here we work and study and thereby develope our bodies and our minds. Home Economics is necessary because, to educate a girl is to educate a family. It is the woman who is not only the mother, but the co-maker of a nation.

# A BRIEF REVIEW OF "KISAN"

By

S. B. Verma.

*(A Book published in Hindi by Mr. M. Husain, 'Kasanaye Noor,' Partabgarh, U. P. and Edited by Messrs. S. F. Alam and Manzur Medarvi.)*

This is a very interesting book; and its publication in Hindi will increase its usefulness in the villages, particularly among the literate cultivators of this Province. They can learn from the various articles and informations contained in the book as to how they can increase the produce from their fields and develope production of their cattle. Besides methods of agricultural improvements, the book gives outlines of cottage industries, health-keeping, hygiene, sanitation, first aid, and village uplift; and such important informations as are very necessary for every-body to learn so as to deal with various public departments such as post offices, courts, etc. A brief statement regarding recruitment to the army and Technical Units and concessions extended to the families of the soldiers has also been made in the book.

Certain proverbs, mostly prevalent in our village, are recorded in this book which will add to the interest of the readers a great deal. The book as its name suggests appears to be of use to a Kisan (cultivator) alone; but its utility can be equally shared by a non-agriculturist also. It has been priced at annas -/12/- a copy.

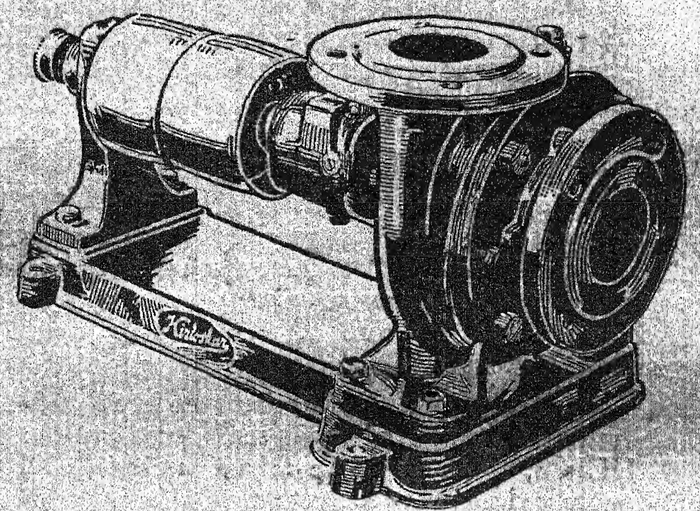
We are glad to find that the book begins with messages of appreciation, the first being from Dr. Sam Higginbottom, ex-Principal of the Allahabad Agricultural Institute, and the second from Mrs. Higginbottom who was head of the Home Economics Department of the College.

---

"We ought never to be so old but that we should like to grow a good variety of fruits or vegetables or flowers or even seeds to produce new kinds. Otherwise, of what significance are the efforts of our experimenters to originate new varieties of fruits? The possibilities for sheer enjoyment in the raising of fruits are unimagined. Fruit growing is a wonderful and captivating subject, full of colour, sunshine, and flavour, with variety and interest for every taste, albeit these rewards may be denied the people. I am convinced that we are not reaching the possibilities and full rewards in the growing of fragrant yields of the earth. We are not making the most of pomology. Emotion and not alone profit-and-loss is a guiding force in human development; it may be well expressed in good fruits of good variety."

—*Dr. Liberty Hyde Batley.*

The Allahabad Farmer Registered No. A·925





*Published by*—The Allahabad Agricultural Institute, Allahabad. U.P. (India)

A. P. BROOKS

VOL. XIX] [No. 4

# THE ALLAHABAD FARMER

A bi-monthly Journal

OF

Agriculture and Rural Life

THE

AGRICULTURAL INSTITUTE, ALLAHABAD, U.P., INDIA

JULY

1945

Education therefore should be directed into practical channels, and it should be the first aim of all of us to do everything that we can to foster and improve that basic industry of agriculture on which India more perhaps than any other country is dependent.

—LORD IRWIN.

YOUR CO-OPERATION

IS

SOLICITED

---

FILL IN THIS FORM

NOW!

I think those below, if not already on your books, may be interested in "THE ALLAHABAD FARMER."

*Signed*________________________________________

*Address*________________________________________

________________________________________

Name________________________________________

Address________________________________________

________________________________________

Name________________________________________

Address________________________________________

________________________________________

Name________________________________________

Address________________________________________

________________________________________

Name________________________________________

Address________________________________________

________________________________________

Name________________________________________

Address ________________________________________

________________________________________

Please address envelope to :

The Editor,<br>
THE ALLAHABAD FARMER,<br>
Agricultural Institute,<br>
ALLAHABAD, U. P.

# THE ALLAHABAD FARMER

## A BI-MONTHLY JOURNAL OF AGRICULTURE AND RURAL LIFE



The Allahabad Farmer is now approved by the Directors of Public Instruction in the United Provinces, Bengal, Central Provinces, Sind, Assam, Bihar and Orissa, the Rural Reconstruction Commissioner, Punjab, and by the Director of the Institute of Plant Industry, Indore, and Agricultural Adviser to Rajputana and Central India States, for use in all schools under their jurisdiction.

### Subscription Rates

Annual subscription : India, Rs. 3; England, 4 shillings; U.S.A., 1 dollar. Single copies, 10 annas; over five years old, 12 annas. Copies which are not received by subscribers will be supplied free of cost within six months of the month of issue. Thereafter single copy prices will be charged.

Unused portions of subscriptions cannot be refunded.

### Advertising Rates

| | Rs. | a. | p. |
|---|---|---|---|
| One full page of six numbers | 35 | 0 | 0 |
| One single full page | 7 | 0 | 0 |
| One half page of six numbers | 20 | 0 | 0 |
| One single half page | 4 | 0 | 0 |
| Page 2 or 3 of cover for six numbers | 50 | 0 | 0 |
| Page 4 of cover for six numbers | 70 | 0 | 0 |

### Contributions

The Allahabad Farmer is published in the first week of each alternate month commencing with the month of January. Contributors are requested to send in their articles at least one month prior to the next prospective date of publication.

Contributors will receive 15 reprints of the article published and additional copies at cost.


*Publisher*—The Allahabad Agricultural Institute, Allahabad, U.P. (American Presbyterian Mission).

*Printer*—The Mission Press, Allahabad, U.P.


## CONTENTS


VILLAGE POWER
grows with
BETTER ROADS

# THE ALLAHABAD FARMER

## A BI-MONTHLY JOURNAL OF AGRICULTURE AND RURAL LIFE



The Allahabad Farmer is now approved by the Directors of Public Instruction in the United Provinces, Bengal, Central Provinces, Sind, Assam, Bihar and Orissa, the Rural Reconstruction Commissioner, Punjab, and by the Director of the Institute of Plant Industry, Indore, and Agricultural Adviser to Rajputana and Central India States, for use in all schools under their jurisdiction.

### Subscription Rates

Annual subscription: India, Rs. 3; England, 4 shillings; U.S.A., 1 dollar. Single copies, 10 annas; over five years old, 12 annas. Copies which are not received by subscribers will be supplied free of cost within six months of the month of issue. Thereafter single copy prices will be charged.

Unused portions of subscriptions cannot be refunded.

### Advertising Rates

| | Rs. | a. | p. |
|---|---|---|---|
| One full page of six numbers | 35 | 0 | 0 |
| One single full page | 7 | 0 | 0 |
| One half page of six numbers | 20 | 0 | 0 |
| One single half page | 4 | 0 | 0 |
| Page 2 or 3 of cover for six numbers | 50 | 0 | 0 |
| Page 4 of cover for six numbers | 70 | 0 | 0 |

### Contributions

The Allahabad Farmer is published in the first week of each alternate month commencing with the month of January. Contributors are requested to send in their articles at least one month prior to the next prospective date of publication.

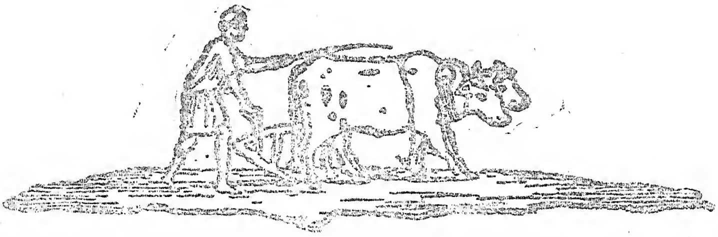
Contributors will receive 15 reprints of the article published and additional copies at cost.


*Publisher*—The Allahabad Agricultural Institute, Allahabad, U.P. (American Presbyterian Mission).

*Printer*—The Mission Press, Allahabad, U.P.


## CONTENTS

# THE ALLAHABAD FARMER



VOL. XIX] JULY, 1945 [ No. 4

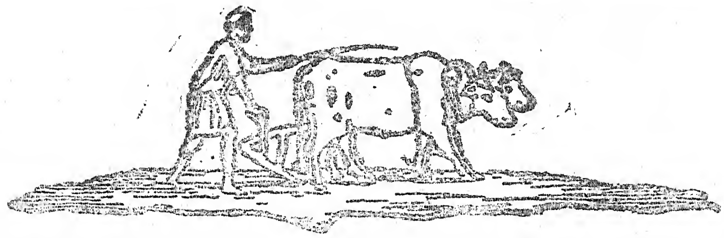
## Editorial

*"Written in September, 1945."*

**Rural Education in Post-War India.**

The war is at an end; peace has at long last come again into the world, and the nations of the world have been brought face to face with the problem of rebuilding it. Reconstruction and rehabilitation are the watchwords not only of those nations that are in the ward-evastated areas, but also of the rest of the nations of the world. This last world war has affected not only those nations that were actively engaged in the war, but also all those that were not so actively engaged. This war was indeed a global war. And we in India, like the rest of the nations, were, whether we wanted it or not, not only involved in it but very deeply affected by it. Our soldiers have fought in almost all theatres of war; they have been to England, France, Germany, Greece, Italy, North Africa, the Middle East, Malaya and Burma; and many have been right round the world. Our leaders and our scientists have gone to various parts of the world so that this country can do its part not only during the war, but also after the war. Up till now this country has been brought up almost completely in the traditions of England, or shall we say the United Kingdom. But this war has not only brought us into very intimate contact with America and other allied nations, but it has also brought to India a greater knowledge of all the other nations of the world. India has, therefore, from this very costly experience got a better estimation of its place among the nations. It knows not only its strength, but it also knows its weakness. Probably it was Professor Saha, the distinguished scientist of this country, who was reported to have said, when he saw the great scientific developments made in that great country America, that he felt like committing suicide as he compared those conditions with those that exist in India to-day. We do not believe that Professor Saha is the only Indian who has had that feeling. There are, we are sure, many of this country who have had the advantage which Professor Saha has had of seeing the great Industrial West, who share those feelings with him. One who has been to any of the industrially developed countries of the world is simply aghast at the very big problem we have in India of building up this country. The problem is so big that it very often results in the feeling of frustration. But with the war now at an end, and with the new visions and new horizons that many of the people of this country have developed, as the result of the war, we have hopes that this country will see better days ahead in the not very distant future. India also is busy planning about reconstruction and rehabilitation; nay India is on the threshold of building a new order. But whatever that order may be, India is agreed on one point and

# THE ALLAHABAD FARMER



VOL. XIX] JULY, 1945 [ No. 4

## Editorial

*"Written in September, 1945."*

**Rural Education in Post-War India.**

The war is at an end ; peace has at long last come again into the world, and the nations of the world have been brought face to face with the problem of rebuilding it. Reconstruction and rehabilitation are the watchwords not only of those nations that are in the ward-evastated areas, but also of the rest of the nations of the world. This last world war has affected not only those nations that were actively engaged in the war, but also all those that were not so actively engaged. This war was indeed a global war. And we in India, like the rest of the nations, were, whether we wanted it or not, not only involved in it but very deeply affected by it. Our soldiers have fought in almost all theatres of war ; they have been to England, France, Germany, Greece, Italy, North Africa, the Middle East, Malaya and Burma ; and many have been right round the world. Our leaders and our scientists have gone to various parts of the world so that this country can do its part not only during the war, but also after the war. Up till now this country has been brought up almost completely in the traditions of England, or shall we say the United Kingdom. But this war has not only brought us into very intimate contact with America and other allied nations, but it has also brought to India a greater knowledge of all the other nations of the world. India has, therefore, from this very costly experience got a better estimation of its place among the nations. It knows not only its strength, but it also knows its weakness. Probably it was Professor Saha, the distinguished scientist of this country, who was reported to have said, when he saw the great scientific developments made in that great country America, that he felt like committing suicide as he compared those conditions with those that exist in India to-day. We do not believe that Professor Saha is the only Indian who has had that feeling. There are, we are sure, many of this country who have had the advantage which Professor Saha has had of seeing the great Industrial West, who share those feelings with him. One who has been to any of the industrially developed countries of the world is simply aghast at the very big problem we have in India of building up this country. The problem is so big that it very often results in the feeling of frustration. But with the war now at an end, and with the new visions and new horizons that many of the people of this country have developed, as the result of the war, we have hopes that this country will see better days ahead in the not very distant future. India also is busy planning about reconstruction and rehabilitation ; nay India is on the threshold of building a new order. But whatever that order may be, India is agreed on one point and

that is that rural India also should be educated. The dumb millions of India who are illiterate should be literate. It is with the idea of contributing our mite in this very great problem of educating our rural India that we make the following observations.

India is and may, for some time to come, remain an agricultural country. It is also a country of villages. If rural India, the India of these villages, is to be educated, the kind of education that it ought to get, should be the one that meets its needs. It should be the education that will have some connection with the after-life of the person we intend to educate. In our opinion, education in village India at the present time is too literary, and not at all related to the life of the pupils or to the life of the group in which the pupil finds himself. It, therefore, stimulates no thoughts and deadens all powers of observations. It has, in a very large measure, made us incapable of using our hands. We feel that this criticism holds good even for higher education. A purely literary education or a "pure science" education has been one of the main causes of the backwardness of this country. This type of education has only too often proved to be a blind alley to many a young man or young woman of this country. That is why an Indian student considers himself or herself as having finished his or her education when he or she finishes university education. This type of education has been, in ample measure, a great loss to this country. The "pure science" education in this country has left us more or less incapable of exploiting or developing the great resources which this country possesses, and which we have, only recently, mainly as the result of this war, realized. The soil and climate, the animals and plants, the rivers and mountains, the hidden mineral resources, the man power, and now the atomic energy, all these we have in abundance and they can be developed or used to advantage for man's happiness, if we but know how. How far can we say that our education in this country has led us in this direction? It seems to us, therefore, quite obvious that education for the rural masses needs overhauling. We are glad, however, to say that in expressing these ideas we are not at all original since they have been expressed off and on for the last sixty-five years or so by those who were appointed by Government to make investigations for the improvment of this country either economically or educationally.

We note that the Indian Famine Commission of 1880 in its report emphasized the very great need for increased technical knowledge of agriculture, and therefore, recommended the introduction of agricultural education in rural schools. The Government of India, acting on the above suggestion, and after spending a great deal of thought on it, resolved in 1888 that "with the co-operation of the Educational Departments measures should be taken which will render the agricultural population capable of assimilating new ideas... ......which will qualify them to take that active part in the scheme of agricultural reform without which no effective results can be expected." Again, as early as 1893, Voelcker, who came to this country from England at the instance of the Government of India, in order to make an inquiry on the subject of the improvement of Indian agriculture, emphasized the need for agricultural education at all stages of education. In the elementary schools, he recommended the introduction of familiar agricultural subjects to the pupils; in the middle school stage, elementary physical science, the use of agricultural primers and illustration plots in which crops are grown; in the high schools stage, more physical science and agriculture, with small farms attached to the schools. In colleges that do not teach agriculture, he recommended that agriculture be one of the subjects. How much progress India would have made in the sciences which are so sorely needed for the development of this country if only we had followed these simple instructions of this sage who came to India with the sole purpose of finding out how this country could make progress. 'The Royal Commission on Agriculture in India of 1928, of which Lord Linlithgow himself was the Chairman, also made similar recommendations.' Then we have the Abbott and Wood report of 1937,

and now finally we have the Sargent report of 1944. Its basic recommendations also, it seems to us, are the same. They also say that "the present system (of education) does not provide the foundations on which an effective structure could be erected". "In fact", says the report, "much of the present rambling edifice will have to be scrapped". The Sargent report then recommended, "that all children must receive enough education to prepare them to earn a living as well as to fulfil themselves as individuals and discharge their duties as citizens." "This", the report says, "is the minimum provision for a national system of education".

Commissions and experts may come and go, but India will go on for ever. So their reports went into the archives of the great Indian Empire with no thought, it seems, that they should ever see the light of day. However, we hope that this will not be also the fate of the last one—the Sargent report.

India is, as stated above, beginning to wake up; as the result of which more and more students are going in for those sciences which will have practical value for this country. This year about 350 candidates applied for admission in the first year class of the Allahabad Agricultural Institute where there are provisions for only 35. We believe that the conditions in other agricultural colleges are similar. In this connection we quote the following statement from the Sargent report: "The High School with an agricultural bias has indeed a most important part to play in the new (educational) system. It will not only contribute towards improvement in agriculture and rural uplift generally, but it will also be the recruiting ground for the teachers whom the rural basic schools will require in such large numbers". The report again says in another place, "In this country with its vast agricultural population, as Senior Basic Schools and High Schools with an agricultural bias become more widely spread, the more advanced stages of Agricultural Education should be closely linked up with the lower, and Agricultural Colleges of every type should be regarded as essential parts of the top educational storey and should come under the general control of the Education Authorities". When the country, therefore, is going to be in dire need of these agriculturally trained men when our rural population is going to be educated in our post-war India, it seems to us very urgent that a serious view be taken of such a situation, when one only out of ten of those who apply for admission into agricultural colleges can be admitted.

It is also our considered opinion that unless Educational Departments have, on their administrative staff those who understand the agricultural problems of the rural population, recommendations of Governments or committees such as those mentioned above, cannot be given effect to. We, therefore, suggest that sub-inspectors and inspectors of rural schools be appointed from amongst those who have had agricultural education. There is no fear that other subjects taught in rural schools will be neglected as agricultural education as given now in all agricultural colleges in this country is a more complete education than any other that we know of which is given in this country. At present all agricultural colleges have English, Chemistry, Physics, Botany, Zoology, Economics, Mathematics, Geology, Climatology, Engineering and Genetics besides such agricultural subjects as Soil Science, Animal Husbandry, Agronomy, Horticulture, Plant Breeding, Plant Pathology, and Entomology. We would further suggest that Directors of Education be assisted in this by Deputy-Directors of Rural Education.

Only by adopting such and similar measures can we hope that rural education will be less urban than it is now, and, therefore, more related to the life of the mass of the population of this country.

Herein, we believe, lies the way to agricultural development which will further lead to industrial progress. Agricultural education, as we find in India today, is very often not "of the soil". It has not grown in the village but it is usually full grown when it is imported into it. That is why rural India very often does not recognize it.

# CHEMICAL CONTROL OF COMMERCIAL FRUIT AND VEGETABLE PRODUCTS.

By

K. C. Batra.

*Chemist, G. G. Fruit Preserving Factory, Agra.*

## INTRODUCTORY

With the development of the science of fruit preservation, the need for scientific control of the manufacture and chemical control of the quality of the raw materials used and of the finished goods has become imperative. In India, the manufacture of fruit products is as yet mostly in the hands of experts who follow simple rule-of-thumb methods. This has resulted in the production of products of such varying quality that it is often difficult for the consumer to stick to one particular brand. Moreover, the additional disadvantage resulting in enormous losses by way of spoilage has aggravated the problem. Needless to say, most of the fruit preservation factories suffer heavy losses every year which could have been avoided if a strict chemical control was exercised over the raw materials used.

Although much has been accomplished toward an exact understanding of the scientific principles underlying the manufacture of fruit products by the fruit laboratories in agricultural colleges, the application of these principles on a commercial scale has not received the attention which they merit. This is due largely to the lack of well-trained fruit technologists who are required to put the industry on the road to progress. The few who are trained as advanced course students in fruit preservation in most agricultural colleges do not know enough chemical analysis. They are also not familiar enough with the fundamental chemical and physical changes of fruits in their industrial processing, and have insufficient knowledge of the sciences of microbiology and nutrition. The time has come when an extensive training in fruit technology of the right type of men is imperative for the best interests of the industry. The technologist should possess the knowledge by which he can develop new products and processes, can exercise proper selection of raw material, and can understand the problems of sanitary handling and incipient deterioration. In addition to this, the development of methods for control of quality in fruit products is one of the chief functions of the fruit technologist.

## SCOPE OF THE WORK

The scope of the work of a fruit technologist in a fruit preservation factory is almost unlimited. He must be a man who knows quite a lot of analytical work and is thoroughly familiar not only with the various processes of manufacture but also understands the effect these have on the nutritive value of the products. With the advance of nutritional knowledge in India, legislation will have to be enacted and enforced to allow only those fruit products in the market which have their nutritive values preserved to a maximum. Already there is a move in this direction and a committee has been formed with Sir S. S. Bhatnagar as chairman and Dr. B. C. Guha as secretary. In the light of the above it is but natural that a manufacturer will have to get his products tested by a chemist as regards their food values before these can be put on the market.

The chemical control of the various materials of the factory can be roughly divided into the following four classes: (1) examination of all kinds of raw materials used; (2) (*a*) control of manufacturing processes with a view to improve them, so that there is the least deterioration in nutritive value as the material is converted from the raw stage to the finished product, (*b*) diagnosis of the causes

of faults in manufacture and devising remedies; (3) examination of the finished products to ensure that they are of the best possible quality with least variation between different batches of a particular product; and (4) utilisation of waste products with a view to reduce the waste to a minimum.

## EXAMINATION OF RAW MATERIALS

Among the main raw materials used in commercial fruit and vegetable products may be included sugar, fruits, preservatives, citric acid, essences and oils, colours, vinegar and acetic acid, water, and tin, glass, or other suitable containers.

### Sugar.

The sugar used should be examined for cleanliness and for ash percentage. It should be free from both soluble and insoluble impurities. The sugar received by fruit factories during war time has been found to contain dirt as an insoluble impurity. Sugar should be tested for the presence of sulphur dioxide as the latter, when present, will produce corrosion in tinned products.

### Fruits.

The constituents to be determined in fruits will depend on the purpose for which these are used. For example, the fruits to be used for jam and jelly manufacture should be tested for pectin and pH value. It has long been established that the best gel formation only occurs at a particular sugar-pectin pH point. In order to take still greater advantage of the analysis of fresh fruits, trials can be made to obtain the optimum conditions for gel formation for a particular variety. Then on this basis the manufacture can be regulated. It should not take more than half an hour to make laboratory trials. The author has been told that this method is being used in a fruit factory in the United Kingdom. If regular records of the data are kept and correlated with the final gel strength as determined by Ostwald's viscometer, a very useful experience can be gained within a short time. Pectin can very quickly be determined by the acetone method as suggested by Morris (1). The method though not very accurate is useful for working purposes.

In the case of fruits to be used for the manufacture of juices and squashes, vitamin C determination is very important. It is only on the basis of this that these products hold a very prominent place from nutritional point of view among commercial fruit and vegetable products. Tomatoes for the manufacture of tomato ketchup and other products should be examined for the number of moulds, yeasts and spores and for bacterial count. This would keep a check on the quality of tomatoes used as tomato products are very sensitive to the attack of micro-organisms.

### Preservatives.

Potassium metabisulphite and sodium benzoate are mostly used as preservatives. The percentage purity of potassium metabisulphite can be found out by determining quantatively the sulphur dioxide. One gramme of this preservative should contain 576·57 milligramms of sulphur dioxide if it is cent per cent pure. The quantity of any preservative to be added should depend on its purity, *e. g.*, a sample with 50 per cent purity should be added in double the amount. The author has been given to understand that in one particular instance a factory had to throw away many barrels of lime juice which was spoiled on account of inadequate preservative. It seems the preservative was added in normal doses not taking into consideration its purity percentage which was very low. Commercial potassium metabisulphite is sometimes only 25 per cent pure.

Sodium benzoate can be detected by extracting with chloroform and precipitation with ferric chloride solution.

## Citric Acid.

During war time, citric acid has been adulterated to a great extent. A sample sold as citric acid was found on analysis in this factory to be potassium hydrogen sulphate. Very often tartaric acid has been sold as citric acid. The latter can be detected by its melting point and various other chemical tests such as calcium chloride and silver nitrate tests. Its percentage of purity can be found out by simple titration with N/10 alkali.

## Essences and oils.

The purity of various essences and oils can be judged by the measurement of various physical constants such as refractive index, iodine value and saponification value. Each particular oil or essence has a definite range of these constants and it is only by a determination of two or more of these measurements that a fair idea can be had of the quality of the material.

## Colours.

The colours generally added to the fruit and vegetable products are mostly restricted to Orange I, Erythrosine, Indigo Carmine, Panceau 3R, Light Green S. F. Yellowish. The purity of a particular colour can be judged easily if its melting point is compared to one of those given above. Arsenic as an impurity should be checked before the colours can be used as this is the only harmful constituent liable to be present. Care should be taken not to carry out the manufacturing processes in lead or copper vessels as appreciable quantities of these materials may be dissolved and contaminate the products.

## Vinegar and Acetic Acid.

Fermentation vinegar can be differentiated from artificial vinegar by determining the oxidation value, which is defined as the number of cc of N/10 potassium permanganate solution required to give a permanent pink colour to 50 c.c. of vinegar containing 3 per cent acetic acid, in the presence of sulphuric acid. The values vary for different vinegars. For distilled vinegar it is about 5, for dilute acetic acid o, for artificial vinegar from 1 to 1·5 and for wine vinegar of 3 per cent. strength from 8 to 12. The method is not easily applicable to cider vinegar for which iodine method is recommended (2).

The presence of acetic acid can be detected by heating it with strong sulphuric acid and alcohol when a fragrant smell of ethyl acetate is produced. Ferric chloride gives a red coloration with a neutral solution of an acetate which is destroyed on addition of hydrochloric acid. On boiling, a brown precipitate of basic ferric acetate is produced.

## Water.

The quality of water used in the manufacture of commercial fruit and vegetable products is of great significance. This is quite essential in the case of tinned products. If the water contains iron and sulphur in more than traces, there is bound to be a good deal of corrosion in tinned products which may ultimately result in 'Hydrogen Swells'. Hardness of water is another factor which requires careful looking into. Hard water used for blanching vegetables will cause hardening and toughening ; though in the case of tomatoes this may be beneficial. Carbonates and sulphates when present in the water used may cause a white precipitate during the preparation of syrup for canning. As is

well known, 'scale deposit' in the boiler used for steam generation is due to the presence of hard water. The quantity of iron in a sample of water should not exceed 4 parts per million while other salts such as bicarbonates, chlorides and sulphates of calcium and magnesium should not exceed 100 parts per million.

### Tin and Glass containers.

The quality of tinplate used in the manufacture of cans for commercial fruit and vegetable products should be the foremost consideration of the fruit technologist. This can be easily judged by the gelatine ferricyanide test. He should use tinplate which has the least surface of exposed iron. The selection of lacquered or plain cans for a particular product has to be decided. Generally, plain cans are preferred as these have been found to give less trouble. But when the quality of tinplate is very bad, lacquering has to be resorted to especially in case of highly acidic fruit products. For the canning of fruit juices a special enamel has to be used. Lacquered cans, on the other hand, are preferred in case of canned products which stand the danger of discoloration such as strawberry and cherries.

The cans should be tested for leaks by pressing them inverted under water with one end seamed. Leaks can be detected fairly rapidly by this simple method. However, the use of compressed air in detecting leaks is more helpful and certain.

Glass containers should be examined for uniformity of surface. A trial should be made to see whether they can stand the sterilisation as many break during this process. Glass bottles should have a uniform neck so that the cork can be pressed inside rapidly.

The containers should be washed before use with water containing small doses of chlorine (3 parts per million) so as to destroy any harmful micro-organisms left.

## CONTROL OF MANUFACTURING PROCESSES AND THEIR EFFECT ON NUTRITIVE VALUE

Commercial fruit and vegetable products can be divided into three broad classes on the basis of their nutritive value :

(*i*) canned products and candied fruits, (*ii*) juices and squashes, (*iii*) jams, jellies, ketchups and chutnies.

### Canned products and candied fruits.

By suitably modifying the manufacturing process, the maximum nutritive value of these products can be retained. For example, in the case of canned fruit products the fruit has simply to be washed, sometimes peeled and cut, and is exhausted while immersed in hot syrup to remove the maximum of air and create a high vacuum. These operations if intelligently carried out will have the least harmful effect on the food value of the product. Similarly, the nutritive value of candied fruits can be retained to a great extent, except for the drastic brine treatment which has a deleterious effect on the vitamins.

### Juices and squashes.

The greatest difficulty with these products is with the retention of vitamin C during the course of manufacture. This vitamin is very sensitive to the action of heat and oxidising agents, and it is very rare that the original vitamin C content of the raw material is preserved to a satisfactory extent. This is especially true of products of our country where the methods used in manufacture

are very primitive and little care is taken to exclude air or heat. Other vitamins, which are generally carotene and vitamin B, are not so easily destroyed and do not offer much trouble. The same is the case with minerals.

Generally, the public is superstitious about the presence of pulp in squashes. So many instances have been brought to the notice of the author that he thinks it would be a definite advantage to the industry if right propaganda was carried out by fruit factories to the effect that the presence of pulp stood for genuineness of the products, and that it is only the pulp which contains the whole of the carotene, which is changed into vitamin A in the body.

### Jams, jellies, ketchups and chutneys.

The boiling treatment needed in the case of these products is so drastic that no vitamins in useful quantity are likely to be left undestroyed. With the open pan system used in India, we do not think that these products contain an appreciable quantity of vitamins. Their nutritive value lies largely in their other constituents, as the calorific value of the sugar, pectin, etc., and to some extent in their mineral content, although the latter may be rather low.

The author is of the opinion that considerable work on the food value of commercial fruit and vegetable products has still to be done in this country and not much can be achieved unless fruit technologists with complete understanding of nutritive chemistry take up the manufacture in their own hands. Mere cries for 'State protection of the industry' will not do unless we can give our countrymen products which bring them health and help to increase their resistance to disease.

## CAUSES OF FAULTS IN THE MANUFACTURE AND THEIR REMEDIES.

Often it so happens that certain minor faults during the process of manufacture are responsible for heavy losses when the products go to the market. It is for the fruit technologist to locate these and avoid them as far as possible. Mere dependence on foremen or supervisors who do not have the theoretical background often leads to trouble. A foreman often does not understand the importance of the immediate sealing of the cans after exhaust so that if the workman who solders the last openings is not ready after the cans are exhausted, the vacuum is bound to be replaced by air and infection take place. Similarly, many faults could be avoided if the man at the top took care to see things for himself. Many a time a little variation in the process adopted makes a lot of difference. To quote a specific instance,—juice extracted out of *phalsa* (Grewia asiatica) by two different methods gave two different colours, one true purple colour and the other dirty brown. Phalsa syrup was made with the juice extracted by the method which gave dirty brown coloured juice with the result that the bottles were returned to the factory with various complaints. At first the quality of the fruit was thought to be the cause, but after thorough investigation it was proved that the method of extraction made the whole difference. Such examples could be multiplied.

## EXAMINATION OF FINISHED PRODUCTS

In order that the products turned out may be uniform in quality so that a customer who once likes a particular products sticks to it, it is absolutely necessary that the manufacturer should adopt certain standards to which he must adhere at all costs. For this it is a very good plan to test each lot chemically before it is filled in cans. This will enable one to keep a strict chemical control over the finished products. To ensure the best quality it is necessary that certain chemical determinations be carried out. In the case of jams, jellies and marmalades, acidity and total soluble solids can be found out. The

acidity should be kept between 0·45 per cent and 0·7 per cent expressed as anhydrous citric acid while the soluble solids can be adjusted so as to give the best gel strength. For juices and squashes acidity and brix can be determined, while for a product like tomato ketchup the determination of specific gravity and acidity should serve the purpose. In the case of canned products, the strength of covering syrup or brine is the main consideration. Of course, the variety of the fruit selected and the grading must be the same at all times.

## UTILISATION OF WASTE PRODUCTS.

In order that any industrial enterprise should prove economical it is necessary that its waste products be utilised to the maximum advantage. Unfortunately, no fruit preservation factory in India has as yet been able to make use of its waste completely. The use to which the waste can be put depends on what constitutes waste. We shall briefly summarize some of the by-products which could be obtained.

### Cattle feed.

Most of the peels of fruits and vegetables can be dehydrated or dried and used as stock feed. Experiments in this direction have been commenced by the writer and he has obtained some very interesting results. Chemical analysis has shown that the feed is rich in carbohydrates and can be used successfully with molasses added at the rate of 1 per cent. Some of the material was sent to the Imperial Dairy Research Institute, Bangalore, which has reported it as having good keeping qualities. Its effect on the quality and yield of milk has yet to be investigated, and experiments in this direction are in progress.

### Pectin.

This can be successfully prepared from apple peels, pomace or albedo of the rind of citrus fruits. The method consists in simple leaching with water containing 0·2 per cent of tartaric acid at 90° F two or three times and then concentrating the extract under vacuo. Though the author has not yet tried this method himself, there are numerous reports to show that the extract is rich in pectinous matter and can be successfully obtained.

### Essential oils.

These can be prepared from lemon or orange peels by simple methods. The peels are grated free of white or albedo portion; pressed under heavy pressure and the oil extracted. The oil can be further purified by either leaving it undisturbed overnight or by shaking it in a separating funnel. Another method consists in distilling the oil by steam under vacuo. The oil is then purified as in the first method.

## CONCLUSION.

The author has tried to describe briefly the various tasks to which a fruit technologist has to devote himself. Besides these there arise daily numerous other problems which constantly require his attention. A good set of books and journals is an asset which he must possess. It is folly on his part to investigate problems which have already been tackled elsewhere and the results recorded in the literature. Sometimes he has to do a great deal within a very short time; and unless he is given necessary facilities little can be expected of him The season for each fruit is strictly limited, and he must finish his experiments within that period; otherwise he has to wait for another year before he can apply his results on a commercial basis. The recent move of the Finance Department of

the Central Government to exempt all expenses on research from taxation should be received with great enthusiasm. It should serve as an impetus for the various manufacturers to start well equipped laboratories with men in charge who possess the requsite qualification. At times capitalists think it unnecessary to spend anything on research. The author must, however, emphasise very boldly that a minor improvement suggested as a result of scientific investigation may yield greater profits than the total expenses incurred in the laboratory.

### Acknowledgment.

The author expresses his heartfelt thanks to Mr. K. P. Bhargava, Proprietor, G. C. Industries, Agra, for permission to Publish this article, and to professors B. M. Pugh and A. P. Brooks, of the Allahabad Agricultural Institute, for their very helpful criticisms and revision of the text.

### References.

1. Principles of Fruit Preservation by T. N. Morris, p. 24.
2. Chemical Analysis of Food and Food Products—Jacobs, p. 335.

## A PROPOSED SYSTEM OF SOIL IMPROVEMENT.

By Mason Vaugh.

*Agricultural Engineer, Allahabad Agricultural Institute.*

The term "soil fertility" may be used to designate these factors which give a certain soil the ability to grow crops of those plants desired by man. While the ability to store and retain water is not generally classed as an element in "fertility," the ability to store water is important in the growing of crops and may be affected by some of the factors which determine fertility.

The soil provides certain things: (1) Certain mineral substance or chemicals, many of them required in only minute amounts, (2) water, (3) support—that is a place for the roots to grow and anchor the plant. In general, the root system which provides an ample absorption system will supply sufficient support. The mineral or chemical substances absorbed from the soil are absorbed as water solutions and are transported to the various parts of the plant in this form. Only soluble parts of the soil are available to the plant.

Soil may be considered as being composed of 3 parts :—(1) Mineral particles, finely broken up rock particles. The larger the particles, the "lighter" the soil; the smaller they are, the "heavier" the soil or the more clay-like it is The texture of the soil is determined by the size of the mineral particles. (2) Organic matter in a more or less decomposed condition. In general, only that which is very finely broken up or decayed is considered a real part of the soil. It is called "humus" in this form and in general carries the nitrogen present in the soil and available to the plants. The presence or absence of organic matter not only affects the supply of nitrogen but profoundly affects the "structure" of the soil and thereby affects the ease with which it can be worked, the ease with which it absorbs water and other properties. (3) Fungi, bacteria and protozoa, the living organisms in the soil. Fungi and bacteria especially feed on the organic matter and convert it into humus, making available the nitrogen and other plant food in it. While some fungi and bactoria are harmful, causing disease, most of them are beneficial because without them organic matter would continue to accumulate in the soil as an inert mass, locking up the plant food they contain and keeping it unavailable to the growing plants.

In general, the mineral particles are the source of the requirements of the plants for minerals Small amounts are supplied by organic manure and it is possible to add the needed chemicals as fertilisers. Generally speaking, chemical fertilisers are relatively expensive and it is desirable to add them only when satisfactory crop yield are not secured without them. Many soils have sufficient amounts of mineral nutrients in them; in others the quantity present in available form may be too little to give crops of the most nutritious quality or too little to give crops of the maximum quantity the soil could otherwise give.

Mineral particles alone, even though they contained an ample supply of the mineral plant foods, would not be productive. Humus derived from organic matter decaying in the soil carries the nitrogen supply necessary for plant growth, to some extent for all plants and entirely for many or most crop plants. Without organic matter, a soil tends to have poor physical condition and so to be less easily workable. Humus supplies certain organic acids which help to dissolve the mineral constituents needed by the plants and so to make them available. It also helps to absorb and hold against leaching away the soluble parts of the soil It supplies food for the soil organisms which serve many useful purposes in the soil, particularly the fixation of nitrogen from the air. A sterile soil is a dead soil, fertile at most for a very short time. Soils in which the mineral nutrients are sufficiently supplied through the use of chemical fertilisers but in which the supply of organic matter is not maintained soon lose physical condition and productivity.

Crops yields, therefore, may be limited by any one of the four factors, biological, chemical or mineral plant foods, water, or physical condition of the soil. Maximum yields of crops will only be secured when all four factors are present in optimum amounts. (Of course, it is recognised that the variety planted also affects the yield, that improved varieties may be necessary to take full advantage of the productive capacity of the most fertile soils. This paper deals only with soil productivity and assumes that the variety planted will be suitable.)

In the more humid arts of India, where the rainfall is 30 inches a year or more, crop yield is most commonly limited by the supply of organic matter in the soil, with the two associated factors of low nitrogen supply and poor water holding capacity. This can be observed in most any village. The fields closest to the village site get most of the manure produced in the villages including night soil, partly because it is easier to get the manure to them and partly because their nearness to the village makes them easier to watch, therefore, the more valuable crops, which are more profitable to manure, are most often planted there. Crops grown in these fields often yield double that of those fields further away which do not get manure.

Experiments on government and private farms all over India, have shown that increasing the organic matter of soils practically always increases the yield, even of the better fields near the village site. This yield increase varies from a comparatively small amount on the most fertile lands to double, treble and even more on the poorer fields. Experiments indicate that increasing the organic matter of the soils of the Ganges alluvium can increase the average yield to at least double the present average This can be arrived at without the purchase of commercial or chemical fertilisers.

If such a result is possible, what are the means of bringing it about? What are the steps necessary and how can they best be brought into Indian farming practice? The rest of this paper will be devoted to discussing these questions.

There are three sources of organic matter for our soils, all at present inadequate or unused. They are (1) crop residues and weeds; (2) farmyard manure, including compost; and (3) green manuring. Under the present system of cultivation and with the implements now in use, the first and third kinds are practically unutilised and the second, farmyard manure and compost, are utilised much less than they should be.

There is considerable literature already available on the value of farmyard manure and compost and on how to prepare and use them. The fullest use should be made of such sources of organic manure. However, were all the barnyard manure and all the compost possible used, there would still be need for more than they can supply. I shall refer to only one thing in connection with these manures. At present, large amounts of cow dung is used for fuel. Compost has been suggested as a replacement for this material. Possibly investigation of the better utilisation as fuel of the weeds, leaves of trees, crop residues and trash which the villager is often urged to compost by the provision of suitable stoves for cooking would make possible the release of the cowdung for manure with less labour than is involved in composting. I consider the labour involved in preparing compost from village waiste one of the great difficulties in its wide introduction in village practce. The manurial value of such compost made from village wastes needs to be compared with the value of such material as fuel in substitution for cowdung cakes. Possibly the difficulty involved in the introduction of better fire places for burning such material economically will be no more than that in introducing the widespread use of compost. Properly designed stoves would have the further advantage in addittion to saving fuel of removing the smoke nuisance from the village kitchen, a desireable thing in itself. Such a stove would also use forest leaves, brush wood, etc., where available.

However, much we may increase to use of farmyard manure and compost, there is still need for better and fuller utilisation of field residues and green manuring, partly because of the insufficiency of the first and because the latter offers a source of nitrogen in addition to that supplied by the former. Field residues remaining after the harvest of the crops are largely or entirely lost because they are mostly blown away by the winds of summer from fields left unploughed till the start of the rains. Some stubble is picked up for fuel. Some is removed—and some grass and weed growth likewise—before the preparation of fields for subsequent planting, either because it interferes with seed bed preparation or because it is commonly believed that they develop certain poisonous or toxic substances in the soil. The true explanation, not commonly understood by the villagers, is that if they are left in the fields and worked into the soil, the bacteria in the soil use the available nitrogen in their life processes while breaking it down. With the very limited supply of nitrogen, the remaining amount is not sufficient to give vigorous crop growth. An increase in the available nitrogen in the soil would make possible the utilisation of this organic matter without the immediate depression of crop growth, resulting in increased fertility. I consider the removal of crop residues, stubble, etc., undesirable as a soil management practice, though in some cases it may be desirable for other reasons, as for instance, where their use as fuel releases more valuable dung manure.

Ploughing just after harvest gives time for the breaking down of this material before time for the next crop to be seeded. There are difficulties involved in this but careful planning will make it possible even with small steel ploughs and small oxen. There are two different problems in doing this, depending on whether the *kharif* or *rabi* harvest is considered. The common practice is to sow *arhar* in rainy season fodder crops, the *arhar* remaining on the fields after the other crop is harvested. Where it is desired to continue this practice, the *arhar* should be sown in lines 5 feet or more apart. If this is done, it is possible to plough with small ploughs between the lines without very much damage to the *arhar*. When a heavy crop of fodder is gotten, usually it will smother out the *arhar* so that as the fertility is increased by the use of manure, it becomes less and less possible to get *arhar* to grow in the fodder Probably, it will be more economical to grow the *arhar* separately and to have the fields clear after the fodder is harvested or if it is harvested for silage, to sow some other crop such as

gram after the fodder. When the fodder crop is harvested, there is usually some moisture left in the soil. The sooner the ploughing can be done, the easier it is to do, as the moisture is lost fairly rapidly. Ploughing just after the harvest tends to kill weeds, stubbles of the fodder crop and other volunteer growth and so to conserve moisture for the *arhar*.

Ploughing after the *rabi* harvest involves even more careful planning of the work. Usually up until the actual cutting of the grain and for a few days after, there is some moisture still in the soil and the soil is not too hard to plough with small ploughs. However, the remaining moisture is lost rapidly after the crop is cut and it is desireable to plough as soon as possible, within a day or two, after the crop is cut. The ideal is to do fields in the afternoon that are cut in the morning and to do the fields in the morning which were cut the previous afternoon. With steel ploughs kept in good condition, this is not difficult to arrange, once a person is convinced of the value of doing it. It is impossible with the wooden plough, except in very exceptional years when there is rain at harvest time or after. If the work is carefully organised, the ploughing can be done, in most cases, in the interval before the grain is dry enough to start threshing, when the oxen are used to trample out the grain The introduction of the steel plough and the planning of the work are the necessary steps in introducing this practice. Where the soil is reasonably soft at the time of harvest, the small steel turning or mouldboard ploughs can be used. When the soil is too hard for them, it may be desirable to use "rooter" type plough bottoms. These can be secured as attachments for some small ploughs.

While the other methods are helpful and should be practiced, probably the use of green manuring crops will be necessary to build up our soils to a high state of fertility and to maintain them there. A green manure crop is one that is planted for the express purpose of being ploughed into the soil as a manure. While any crop so treated will increase the organic matter, the legumes are more desirable than non-legumes because they increase the nitrogen supply as well as the organic matter. Part of the desirable effect of green manuring can be secured by the growing of a suitable legume crop as part of the regular crop rotation. The soil fertility will be increased most rapidly if every field has a legume green manuring crop every year. Where this is not possible, the next best thing is to have a green manuring crop one year and a suitable legume the following, or alternate, years. For soil building, it is necessary that the legume be suitable, that is not only have nodules on the roots but that it actually store nitrogen than it removes from the soil. Some legume crops, soya beans for instance, are desirable as crops but not soil builders because they leave less nitrogen in the soil than was present when they were planted.

In order to introduce a programme of soil building including green manuring, certain conditions will have to be met. First, suitable implements and procedures for their use will have to be introduced. The minimum implement used for green manuring is a small steel plough. While green manuring can be done with small mould board ploughs, the larger the plough used the more satisfactory the work will be. However, while larger ploughs are desirable, a green manuring programme can be carried out with small ploughs. Second, the green manuring crop must not occupy the land at a time it is required for a crop which is to be harvested. The margin of production is so small that we cannot afford to lose the use of land even for one crop season, in order to do soil improvement on the village holding. Where only one crop each year is grown on a given field, as is commonly true in most parts of India, it is easily possible to get a green manuring crop in the *kharif* season on fields to be planted to *rabi* as will be explained later. In the case of fields planted to *kharif* crops, the growing of a green manuring crop following it is not so easy but suggestions will be made as to how this also may be possible, without changing the rotations now followed. Third, the work of planting and turning under the green manure crop must not interfere with work on har-

vested crops at the seasons of rush work. Under present conditions, there is no time to spare at the season when crops are bei g planted and the green manure crop will always be deferred if it must compete for time and attention with a crop yielding food, fodder or fibre. Fourth, it is desirable that the green manuring crop be one that is not particularly good for human food or animal feed, lest there be temptation to harvest it for immediate gain rather than to plough it in for futher benefit through soil improvement. As pointed out before, some crops which are harvested also may benefit the soil but probably, not to the same extent as would a high quality green manuring crop turned into the soil.

It is quite easy to meet these conditions, assuming that small steel mouldboard ploughs are available, on land that is to be sown to *rabi* crops. By careful planning as explained above, it is possible to plough these fields at the end of the previous harvest. If they are roughly ploughed into even fairly large clods, well before the beginning of the rainy season, *sann* can be sown by simple broadcasting of the seeds among the clods before the rains start. The seed is not injured by lying in the hot soil or exposed to the sun, birds do not seem to pick it up, nor do insects seem to destroy it. The melting of the clods provide enough soil cover to bury the seed quite deep enough for good germinations. Leaving the soil rough on the surface is actually an advantage as the space between the clods provides pockets to hold therein till it can be absorbed instead of running off and a rough surface absorbs more moisture or absorbs moisture more rapidly than does firm compact soil. In this way, the seeding of the green manure crop is completed before the beginning of the seeding of the *kharif* harvest crops, and does not interfere with other work at that time. Similarly, whether green manuring crops are grown or not, it is necessary to start ploughing the field reserved for *rabi* crops about the middle of August if they are to be in good condition for the *rabi* crop.' If this is not done, the growth of grass and weeds becomes too heavy to be handled by small ploughs, too much moisture is lost, the available plant food is tied up in the weed growth which does not decay in time to release the plant food for the succeeding crop. Being undecomposed, they interfere with cultivation also. The time for starting the fall preparation of the *rabi* seed bed is the time when the *sann* should be ploughed under for green manure. The two are one operation and the seed bed is prepared in the normal manner thereafter. In this way, the cost of the green manure crop is only that of the summer ploughing and the seed used. The ploughing of all land at the time of the previous harvest is not only practicable but good soil management practice as well

Assuming the availability of the steel ploughs, this system meets all the conditions. The crop does not compete with a harvest crop either for the land or for the time of the farmer. The *sann*, while an excellent green manuring crop and of some considerable value when mature, is not mature enough at the time it should be ploughed in to be of value for fibre, it is not commonly used as a fodder or food crop (except occasionally for goats) and the value of the following crop is usually much greater than the value of the *sann* if left standing till mature. Thus it should be easy to introduce the practice of growing a green manuring crop on all land to carry a winter or *rabi* crop.

Growing either a green manuring crop or a harvested legume after the *kharif* crop is not so easy as is the growing of a green manuring crop during the *kharif* season preceding a *rabi* crop. It is practicable to grow most legumes as interplanted crops with maize, *juar* or *bajra* only when these crops are thinly spaced. *Arhar* will survive more smothering than some of the other legumes but even it is smothered when the fodder crop is very heavy. In most cases, where the soil is fertile enough to grow heavy crops of these *kharif* fodders, it will be more pofitable to seed them so as to fully occupy the ground, growing the legumes wanted for harvest as separate crops rather than as admixtures. If we consider the agricultural year as beginning with the onset of the monsoon, any soil building crop or at least any green manuring crop grown in the same year as a *kharif* harvest

crop must follow the harvested crop rather than precede it as in the case discussed before of *rabi* fields. If the *kharif* crop is allowed to mature seed as is commonly done, by the time it is harvested, the soil moisture is low and by ordinary methods of seed bed preparation more moisture is lost. In contrast to the green manuring crop grown during the rains, the preparation of the seedbed and seeding of the green manuring crop at this time has to be done somewhat in competition with the seeding and care of the *rabi* crops. There is no generally recognised green manuring crop now commonly grown in India which is suitable for these conditions. Certain things are under test at the Agricultural Institute in the attempt to find both a method of seeding and a suitable crop for growing a green manuring crop after a *kharif* crop on the residual moisture in *barani* land.

Certain changes in present farm practice, consistent with the above recommendations for *kharif* green manuring, would somewhat simplify these difficulties. Early ploughing makes possible early seeding and, therefore, early maturity of *kharif* crops. Sorghum has been successfully seeded directly into fields ploughed in the dry weather, without intermediate seed bed preparation, immediately after the first rain, thereby getting growth started 2 to 3 weeks before crops seeded by common methods in fields wholly prepared after the rains start. This practice is good crop insurance in itself. The use of maize or the selection of an earlier maturing variety of sorghum would make possible an earlier harvest. Putting most of the sorghum grown into the silo for cattle fodder when still green and immature would also clear the fields earlier, and increased yields due to soil improvement would compensate for the loss of the grain from comparatively low yielding *juar* and *bajra*.

The adoption of the above suggestions would narrow the problem to finding a suitable crop and developing the necessary farm practice to go with it. Gram is generally recognised as being beneficial to the soil, it is a desirable food grain, requires the minimum of preparation of the soil and of moisture for good growth. It can utilise the small amount of moisture sometimes available better than any other common crop. If the practices recommended in the previous paragraph are adopted, the remaining change necessary is the development of a suitable procedure and equipment for seeding the gram with the least difficulty. Sufficient experimentation has not yet been done to recommend with confidence any one method. The following may be suggested as suitable things to be tried: (1) the preparation of the seed bed by the use of some tool which would only scarify the surface, getting the effect of a light disk harrowing; (2) the possibility of using some sort of a blade harrow, possibly a modification of the Acme harrow might be explored. (The use of the disk harrow is not suggested as it has not proven suitable for use with small oxen and the recommendations in this paper are confined to things which can be done with small oxen as power); (3) the possibility of seeding the gram with grain drills equipped with disk or runner furrow openers, directly in the stubble of the summer crop without any further preparation of the seed bed whatever may be tried. Disk or runner furrow openers are suggested rather than hoe type openers because of the necessity of cutting through the trash. Alternatively, disk coulters might be set ahead of the furrow openers. Most weeds present would be nearing maturity and the gram may be able to smother winter weeds if a suitable method of planting can be found. Other legumes than gram should be investigated in the hope of finding something still better, particularly one which would make good growth on minimum moisture when planted later than the common season for planting gram or possibly the development of a variety of gram especially adpoted to late planting, in late November or December.

Among other possibilities that needs more investigation is the possibility of finding a legume which would lie more or less dormant while the land was occupied by the *kharif* crop, but would grow and develop when the crop was removed, and which would be adopted to the short days of winter and to comparatively

little moisture in the soil. Such a plant might be one which re-seeds itself with seed which lie dormant till the early winter season and then germinate. A plant which could be sufficiently torn up by the seed bed preparation to not offer objectionable competition with the crop but still remain alive and ready to grow when conditions are favourable might be useful. Kudzu has been suggested as such a possible crop. Winter vetch has been suggested as a legume to investigate. Investigations of these have not progressed to the point where anything definite can be said about them as yet. Investigation of a number of legumes is being continued at the Allahabad Agricultral Institute in the hope of finding something which will fit the conditions of growing with a minimum of moisture in the Ganges valley during the months of November to February, which will fix nitrogen from the air and which is otherwise suitable for green manuring. If such a legume can be found, methods of growing it will be investigated. Suggestions from readers will be welcomed as to legumes likely to be suitable.

Experience at Allahabad and elsewhere shows that increasing organic matter increases yields. Consistent following of this system of soil improvement will increase the yield of crops, without the use of commercial fertiliser or anything which has to be purchased and without interfering with the normal production of food grains during the soil building programme. It has been shown that the soils of the Ganges valley contain enough of the mineral elements to support *yields* far above those commonly secured, if nitrogen is supplied and if the physical condition of the soil is improved by addition of organic matter.

The question of *quality* of crop is yet to be investigated. Recent investigations in America have shown that the nutritive quality of crops may vary widely, depending on the amount of available lime and phosphate in the soil. Animals not only grow more rapidly and yield better and more animal products when fed on the crops from soils having adequate supplies of phosphorus but the animals themselves will choose the grass or other crop from the soil having the right balance of nutrients, when given a choice. As yet, no tests have been made at Allahabad to determine, whether it is necessary to use commercial fertilisers to secure the best *quality* of crops or not. This is still to be investigated and is important.

The author of this paper is convinced that this system of building soil fertility is practicable for the ordinary farmer and that it can be introduced generally in the villages. It is certain, however, that in order to do so, it will be necessary to introduce a whole system, not simply to advocate "green manuring" or "improved ploughs" or some other single item. The whole system needs to be demonstrated and explained as a unit.

Comment, suggestions or criticisms of the system is invited with a view to making it more perfectly adopted to the needs of the Indian farmer. We will be glad to hear of the experience of other workers with this or similar systems of building up soil fertility. We are convinced that it is one of the ways in which the income of the farmer can be most rapidly increased with a minimum of change in the general system of farming.

# MANURES AND MANURING

SUDHIR CHOWDHURY

## Chapter VII

### NIGHT SOIL

The term 'night soil' has long been applied to human excrement. Human excrement is rich in nitrogen and phosphoric acid. It has been used in manuring fields in China from ancient times. In India crude night soil is used as manure to a considerable extent in the neighbourhood of the smaller towns in the Bombay Presidency. In other parts of the world, however, this has been used with great reservation as a manure. This is due to handling difficulties and to its being a ready medium for the conveyance of the organisms which cause various types of human diseases.

### Amount of Urine :

It was found by Lecanu in experiments with 16 persons of different ages and sexes that the excrement of urine per 24-hours ranged from 525 to 2,271 gms. In experiments conducted on himself Lehmann found in a 14-day test with a mixed diet, that the daily excretion of urine amounted to from 879 to 1,384 gms. and in the course of a 12-day vegetable diet, it fell to from 720 to 1,212 gms. Based upon these and other data, it is probably safe to estimate the average daily excretion of urine, per capita at about 1,200 gms. (about 4.2 lbs.).

The solid matter in human urine has been based upon the work of several investigators to range from about 34.5 to 87.4 gms. per day, though it is said to vary with the different nationalities. This variation may, however, be due to temperature and other climatic conditions rather than to constitutional differences.

The following percentages given by Lehmann, represent the relative quantities of some of the more important constituents of human urine :

| | Urea | Uric Acid | Extractive substances and salts |
|---|---|---|---|
| With a mixed diet ... | 32·5 | 1·18 | 12·8 |
| With an animal diet ... | 53·2 | 1·48 | 7·3 |
| With a vegetable diet ... | 22·5 | 1·02 | 19·2 |
| With a nitrogen free diet ... | 15·4 | 0·74 | 17·1 |

It has been found that the percentage of nitrogen in the urine of children of 8 months old is about 0·15 ; in that of men 21 years old 1·02 and in that of men 46 years of age 1·57 to 1·84. Based upon an average of 1,200 gms. of urine per 24-hours per individual the average daily excretion of nitrogen in the urine would amount to 13·36 gms.

The quantity of non-combustible salts is least in the urine of children, followed in turn by the urine of women, aged people and men. The variations, however, in individual cases and within these groups are very great. The chief constituents of the ash of urine, named in order are chlorine, soda, potash, phosphoric acid, sulphuric acid, lime, magnesia and iron dioxide, slight amounts of insoluble matter making up the remainder.

### Amount of Solid Excrement :

The average quantity of solid excrement per day, as found by Lawes and Gilbert, for boys under 16 years of age, was about 108 gms.; for men between 16 and 50 it was about 152 gms.; and for men over 50 years of age about 226 gms. The dry substance ranged from 27·4 to 42·3 per cent; it was found to be the greatest in the case of old men.

### Chemical Composition of Solid Excrement :

The amount of nitrogen present in the average daily solid excrement of boys was 2·34 gms.; of men 1·94 gms.; and of old men 0·321 gm. The quantities of ash were 3·69, 4·23 and 8·32 gm. respectively. In the ash the phosphoric acid has been found to range from about 31 to 43 per cent; the potash from 6 to 21 per cent, lime from about 17 to 27 per cent and magnesia from about 10·5 to 15·5 per cent.

### Composition of Human Excreta :

Hall, however, gives the following analysis for human excreta :

| | Faeces | | Urine | |
|---|---|---|---|---|
| | Per cent | lbs. per annum | Per cent | lbs. per annum |
| Water ... | 77·2 | ... | 96·3 | ... |
| Organic matter ... | 19·8 | ... | 2·4 | ... |
| Ash ... | 3·0 | ... | 1·3 | ... |
| Nitrogen ... | 1·0 | 1·04 | 0·6 | 6·9 |
| Phosporic acid ... | 1·1 | 1·3 | 0·17 | 3·2 |
| Potash ... | 0·25 | 0·3 | 0·2 | 3.4 |

### Utilisation as a Manure :

Many attempts have been made to utilise the fertilising materials contained in human excreta ; on the crowded lands of China it is applied fresh to the soil and is daily fetched by hand from the cities for that purpose, but this mode of dealing with night soil is very unhealthy and is only possible with an excessively low standard of living. In the towns of Flanders and the north of France it was the custom to collect the excreta in large tanks, and after fermentation to cart them out in a liquid form to the fields, though modern views on public health are rapidly getting rid of such practices.

### Earth Closet System :

Almost the only method of getting human excreta back to the land cheaply and inoffensively is in houses or small communities where the earth closet system prevails. There the excreta are mixed with dry shifted earth, which, deodorises them quickly and completely ; the mixture is removed daily to a heap under cover and in a very short time the faecal solids are so completely broken down by bacterial decay that the soil can be spread upon the land and used for growing crops.

### Poudrette from Human Excrement :

One of the products sold under the name of 'poudrette' is prepared by the Liernur process which consists in adding to the excrement sufficient sulphuric acid to fix the ammonia arising from the urea, sometimes with powdered turf, etc., to give the finished material a better mechanical texture, after which the mass is evaporated in a vaccum until it reaches such a consistency that it can be completely dried by other means and finally reduced to a powder.

The following analysis shows the composition of the resulting manure :

| | |
|---|---|
| Water | ... 13.9 |
| Organic matter | ... 63.7 |
| Containing : | |
| Nitrogen | ... 6.74 |
| Phosphoric acid | ... 3.12 |
| Potash | ... 2.16 |
| Insoluble ash | ... 3.45 |

### Excrement Treated with Lime :

This method is said to have been first proposed by Payen and then by Muller and upon it is based the system of Mosselmann and Muller-Schur. By this process the ammonia which has been formed previously in the mass is lost. It is, therefore, important that the excrement be treated in as fresh a state as possible. Mosselmann used two parts by weight of burned lime to one of moist excrement and the final volume amounted to $2\frac{1}{3}$ times that of the lime employed. In this process 100 parts by weight of lime volatilize about 25 parts of water and bind chemically and mechanically, about 50 parts more, thus producing a product which is so dry that it can be readily handled and transported and the heat generated is sufficient to destroy pathogenic organisms. The composition of the product formed has been found so in certain manufacturing villages in Rhode Island :

| | | |
|---|---|---|
| Calcium oxide | ... | 11.28 per cent |
| Potash | ... | 0.09 |
| Phosphoric acid | ... | 0·91 |
| Nitrogen | ... | 0.43 |

One great objection to the material so prepared is that it is excessively rich in lime and if it were applied regularly in sufficient quantities, it would result in liming the soil to excess.

### The A. B. C. Method :

In the absence of burned lime, alum, blood, and clay are added to the fresh excrement after which it is dried and ground. This process takes its name A. B. C. from the first letters of the names of each of the materials added to the excrement. The Method of Thon is based upon evaporation of the water by means of artificial heat. The product as prepared by Thon at Stuttgart had the following composition :

| | | |
|---|---|---|
| Nitrogen | ... | 4.5 to 6 per cent. |
| Phosphoric acid | ... | 10 to 12 |
| Potash | ... | 1.5 to 3 |

### Method of Sundermann :

This method was adopted in connection with a hotel in Breslau, Germany. The excreta in this case were placed in a retort where they were not only dried but also subjected to dry distillation, in the course of which there were produced illuminating gas, carbon dioxide, tar and ammonia. The valuable products were saved; the gas after the removal of the carbon dioxide and subjugation to other purification, was used for illuminating purposes in the hotel. The resulting ash with a content of 5·57 per cent of water was found to contain :

| | | |
|---|---|---|
| Lime | ... | 6.5 per cent |
| Magnesia | ... | 3.0 |
| Potash | ... | 5.5 |
| Phoshoric acid | ... | 8.6 |

### Sewage :

In cities and towns the almost universal prevalence of a water-borne system of dealing with excreta puts an end to all such systems and intensifies the difficulty of saving the fertilising constituents of human excreta for the land, because of the enormously increased dilution they have experienced. Every 1,000 parts of sewage is composed of 998 parts of water and only two parts of solid matter; of the latter, half is organic matter and half inorganic or mineral matter. To utilise the fertilising value of the sewage, the latter is applied to the land in practically the same way that water is applied in ordinary irrigation. The use of sewage as a substitute for water in irrigation might be practiced to advantage throughout all parts of the country which suffer periodically from scanty rainfall and it might often be practiced as a temporary measure during droughts even in the humid regions. When the volume of sewage is large, compared with the area of land available, or when the land is heavy and not naturally well drained or easy of drainage, it may be necessary or advisable to submit the sewage to preliminary treatment for the removal or reduction of solid matters which would clog the surface of the land. Chemical treatment with sedimentation will remove a large part of the solid matter; plain sedimentation will remove less, and screening or straining still less. If the sewage is passed through a long, narrow and relatively shallow tank or tanks so that it will take twelve to twenty-four hours to make the journey 30 to 50 per cent of the solid matter will be removed; some will be transformed into gases, some liquified and made more susceptible to oxidation, and some will remain in the tank as sediment or sludge. By this means less solid matter is passed to the sewage farm and most of what goes is more easily converted into plant-food than when applied in its crude state.

### Sludge :

The chemical composition of sewage sludge varies with the kinds of chemical used as precipitant. The following table gives a series of analyses of such sludges, made for the Royal Commission on Sewage Disposal in 1906, which may be taken as typical of this class of material :

| | | I | II | III | IV |
|---|---|---|---|---|---|
| Water | ... | 10·1 | 31·2 | 40·6 | 3·55 |
| Organic matter, etc. | ... | 49·8 | 24·9 | 16·8 | 38·23 |
| Nitrogen | ... | 2·32 | 0·94 | 0·55 | 1·65 |
| Phosphoric acid | ... | 2·27 | 0·80 | 1·42 | 1·25 |
| Lime | ... | 2·34 | 24·6 | 24·45 | 8·40 |
| Potash | ... | traces | traces | traces | traces |
| Insoluble matter | ... | 23·27 | 7·06 | 5·57 | 28·28 |

Of these sewage sludges I represents the material obtained by using as precipitating agents, lime, alum and sulphate of iron and then freeing the precipitated sludge of excess of moisture by passing through some form of pressure filter and then drying, II and III are lime sludges, while for IV the precipitant had chiefly been sulphates of iron and alumina. It will be seen that inno case is the material possessed of much fertilising value Field trials show that the action of these sludges as manures is very small. It seems desirable to conclude that these sludges possess little or no value as manures, though they may be valuable for the lime they contain, especially on light sandy land where they will also add some water-retaining humus and improve the texture of the soil.

*References* :


Bailey, L. H. ... Cyclopedia of American Agriculture, Vol. I

Hall, A. D ... Fertilizers and Manures.

Lyon, T. L. ... Soils and Fertilisers.

Wheeler, J. H. ... Manures and Fertilizers.

Rafter, G. W. ... Sewage Irrigation.

Rafter, G. W. and Baker, M. N. ... Sewage Disposal in the United States.

The use of Crude Night-Soil. Bom. Dept. Agri. Leaflet 10, 1915. Some Chemical Characteristics of Sewage Sludge, Jour. Ind. Eng. Chem. 19, p. 233 and p. 1012, 1927.


## NUTRITION VALUES OF MAIZE, WHEAT, RICE AND BARLEY.

According to W. P. Ford, (*Chem.* and *Indust.*) maize has a higher oil content than other cereals, has less calcium, magnesium, iron and phosphorus than wheat, but the nutritive values of whole maize proteins and wheat proteins are similar. Except as a source of easily digested carbohydrate polished rice is, from the nutritional point of view, the least valuable of the cereals. Barley contains twice as much fibre, about 0·7 per cent more ash and 2 to 3 per cent less protein, but otherwise is similar in composition to wheat.

## THE UNITED PROVINCES GOVERNOR VISITS THE INSTITUTE.

Sir Maurice Hallet, Governor of the United Provinces, as is his custom every year whenever he comes to Allahabad, visited the Institute this year on the 8th of August. On arrival at the Institute His Excellency and his party were entertained to tea by the Principal and his wife, Dr. and Mrs. J. L. Goheen, at which some of the senior members of the staff of the Allahabad Agricultural Institute were also present. After tea His Excellency and his party were taken around to see the various activities of the Institute. They started with the Animal Husbandry and Dairy Department in which they were shown the beautiful herd of Sindhi cows, which has been increasing in number every year so that, at present, the Institute has about 200 of them. The party also saw the pig section, which has increased considerably in the number of animals and in the amount of equipment because of the war. The number of pigs at the time was about 400 and the Institute has been supplying to the Army eight slaughtered animals every week. His Excellency showed a keen interest in examining the equipment in the slaughter house and also in the storage room. The party also saw the poultry, ducks, turkeys, guinea fowls, all of which have increased considerably in number in recent years. His Excellency was also keenly interested in artificial insemination, which is a new method of impregnating the cows or other animals with the semen from proven males. This method is commonly used in America, Russia and other countries, where the science of Animal Husbandry has made considerable progress. By this method the service of a bull may be extended ten to fifteen times. The Institute has been able, with the present equipment, to extend the service about five times; *i.e.*, instead of serving say 100 cows, it has by this method, been able to increase the service from bulls to about 500.

The party was then conducted to the orchards of the Institute in which grapefruit was of special interest to His Excellency. The party was also shown the various methods of propagating fruit trees and the work done by students in this connection. After visiting the orchards His Excellency and the party were conducted to see the workshop of the Agricultural Engineering Department of the Institute, in which His Excellency was shown the manufacture of ploughs, cultivators and various other agricultural implements. The work of this section of the Department has also increased considerably in recent years. The party also saw the treadmill, which has been used for more than a year in connection with the bullock-yoke and draft ability research scheme. After going through this section the party was taken around to see the work on the farm as usual. The great work of reclaiming the land by the building of dams and terraces and by contour cultivation was of interest to His Excellency and the party. His Excellency then saw the crop varietal tests and also the experiments on crop rotation as laid out in the field according to the Fisherian method of laying out field experiments. In the end His Excellency saw the vegetable gardens of the Indian soldiers, who are here for a year's training in agriculture so that they may be able, to teach the other soldiers who will be demobilised at the end of the War. The party then, after a short visit with the Principal and his friends at the end of the tour through the Institute, took leave of the host and hostess, thanking them for the useful time spent at the Institute.

"We have not failed on the scientific front; we have failed on the moral front. We see that the broad and vital problem is not in how to feed the world, but how to make it possible for the world to feed itself. Only by boldly and unselfishly meeting this challenge can we hope for permanent peace. Too many men and nations have profited and hope again to profit from the poverty and low standards of so-called 'backward nations.' It will be the retention and application of this philosophy which will again sow the seeds of wars and still more wars......"

—MURRAY D. LINCOLN.

# WANTED

# OLD NUMBERS

OF

# The Allahabad Farmer

The Business Manager of the Allahabad Farmer will pay at Re. 1 per copy for the following issues. Copies may be sent to him by V. P. P.

| | | | |
|---|---|---|---|
| Vol. I | January, 1925 | ... | No. 1. |
| | April, 1925 | ... | No. 2. |
| | July, 1925 | ... | No. 3. |
| Vol. II | October, 1926 | ... | No. 4. |
| Vol. IV | July, 1930 | ... | No. 3. |
| Vol. V | July, 1931 | ... | No. 3. |
| Vol. VI | January, 1932 | ... | No. 1. |
| Vol. VII | January, 1933 | ... | No. 1. |
| | September, 1933 | ... | No. 5. |
| | November, 1933 | ... | No. 6. |
| Vol. VIII | January, 1934 | ... | No. 1. |

Published by :—The Allahabad Agricultural Institute, Allahabad. U.P. (India.)

VOL. XIX] [No. 5

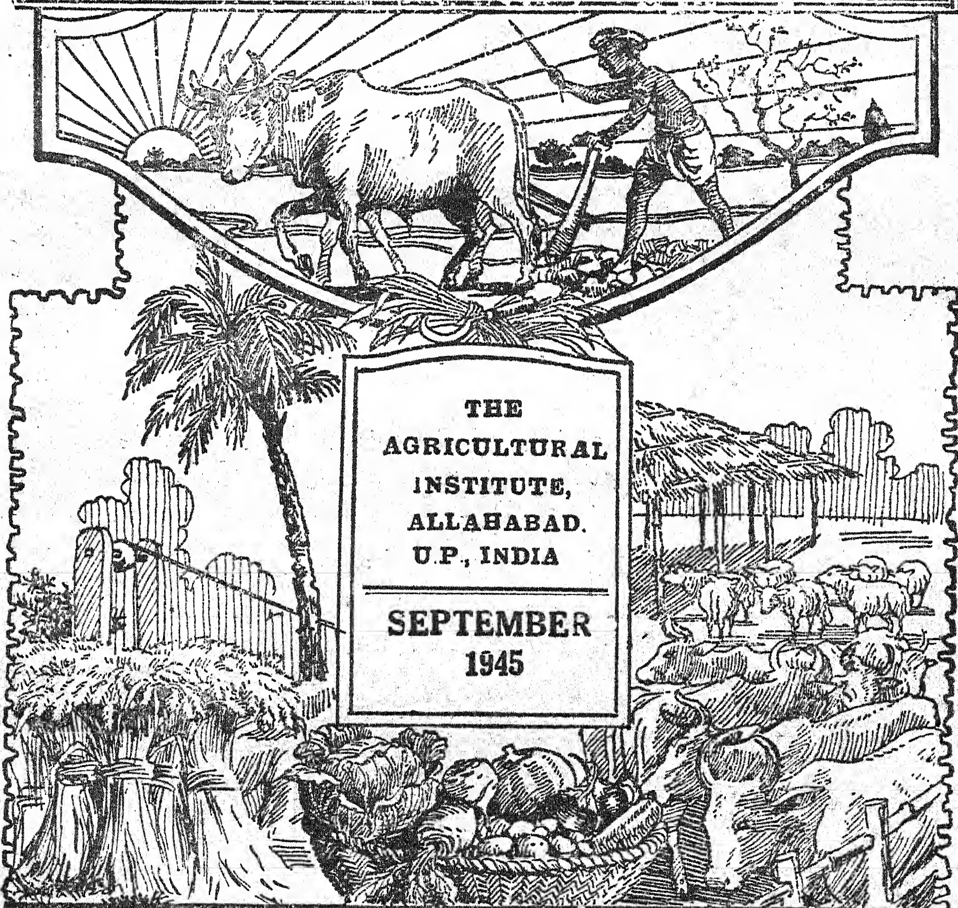


# THE ALLAHABAD FARMER

A bi-monthly Journal

OF

Agriculture and Rural Life



THE
AGRICULTURAL
INSTITUTE,
ALLAHABAD.
U.P., INDIA

SEPTEMBER
1945

"The land yields its increase to the husbandman who watches over and cares for it with understanding and skill. The earth rewards richly the knowing and diligent. This partnership of land and farmer is the rock foundation of our complex social structure."

—WALTER C. LOWDERMILK—

YOUR CO-OPERATION

IS

SOLICITED

---

FILL IN THIS FORM

NOW!

I think those below, if not already on your books, may be interested in "THE ALLAHABAD FARMER."

*Signed*..........................................................................

*Address*..........................................................................

..........................................................................

Name..........................................................................

Address..........................................................................

..........................................................................

Name..........................................................................

Address..........................................................................

..........................................................................

Name..........................................................................

Address..........................................................................

..........................................................................

Name..........................................................................

Address..........................................................................

..........................................................................

Name..........................................................................

Address..........................................................................

..........................................................................

Please address envelope to :

The Editor,
THE ALLAHABAD FARMER,
Agricultural Institute,
ALLAHABAD, U. P.

# THE ALLAHABAD FARMER

## A BI-MONTHLY JOURNAL OF AGRICULTURE AND RURAL LIFE



The ALLAHABAD FARMER is now approved by the Directors of Public Instruction in the United Provinces, Bengal, Central Provinces, Sind, Assam, Bihar and Orissa, the Rural Reconstruction Commissioner, Punjab, and by the Director of the Institute of Plant Industry, Indore, and Agricultural Adviser to Rajputana and Central India States, for use in all schools under their jurisdiction.

### Subscription Rates

Annual subscription : India, Rs. 3; England, 4 shillings; U.S.A., 1 dollar. Single copies 10 annas; over five years old, 12 annas. Copies which are not received by subscribers will be supplied free of cost within six months of the month of issue. Thereafter single copy prices will be charged.

Unused portions of subscriptions cannot be refunded.

### Advertising Rates

| | Rs. | a. | p. |
|---|---|---|---|
| One full page of six numbers | 35 | 0 | 0 |
| One single full page | 7 | 0 | 0 |
| One half page of six numbers | 20 | 0 | 0 |
| One single half page | 4 | 0 | 0 |
| Page 2 or 3 of cover for six numbers | 50 | 0 | 0 |
| Page 4 of cover for six numbers | 70 | 0 | 0 |

### Contributions

The ALLAHABAD FARMER is published in the first week of each alternate month commencing with the month of January. Contributors are requested to send in their articles at least one month prior to the next prospective date of publication.

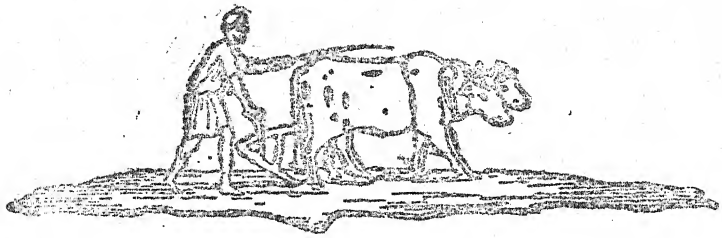
Contributors will receive 15 reprints of the article published and additional copies at cost.


*Publisher*—The Allahabad Agricultural Institute, Allahabad, U.P. (American Presbyterian Mission).

*Printer*—The Mission Press, Allahabad, U.P.


## CONTENTS

# THE ALLAHABAD FARMER



VOL. XIX] SEPTEMBER, 1945 No. 5 ]


## Editorial

**The Allahabad Agricultural Institute moves forward.**

In this September issue of the Allahabad Farmer, we again present to our readers the reports of the various departments of the Allahabad Agricultural Institute. The Institute since its inception has been making steady progress in spite of the many difficulties which confronted it especially in the formative period of its life. It was difficult in the early days of the Institute to convince the Indian public that agriculture was such a subject that it should be included in college curricula. From the point of view of the supporting public in America it was also difficult to convince them that this was one way by which the American public could serve India. But ideas on this subject, both in India and in America, are changing very rapidly. Agriculture is now regarded as a fit subject for study in all Indian universities. M. Sc. courses in agriculture are springing up in a number of places in this country, and even Ph. D. degrees are being conferred on those who have successfully completed original research work on certain phases of agriculture. In bringing India around to this conviction, the Institute has played no mean part. It took considerable time to get the Institute recognized by the Board of High School and Intermediate Education of the United Provinces in which we are located. This recognition came in 1925, about 15 years after the Institute was started. Previous to this—to be exact, in 1924—the Institute had been recognized by the Imperial Government as one of the two institutions in this country which teach the course in Animal Husbandry and Dairying which leads up to a diploma granted by the Imperial Government and known as the Indian Dairy Diploma. In fact, when the Imperial Government decided to institute such a course, invitations were sent out to the provincial institutions, but none responded to the invitation except the Allahabad Agricultural Institute. The Imperial Government, therefore, allowed the Institute to teach the course which it has been doing ever since. The Imperial Government at the same time started an institute at Bangalore to teach the course, so that thus far the Allahabad Agricultural Institute is the only one in Northern India teaching this course.

Again it took a considerable time to get the Institute recognized for the teaching of agriculture for a University degree. There were questions in university circles whether an agricultural course, especially one taught outside the university, could come up to the university standard. The University of Allahabad, after prolonged discussions, granted in 1934 this privilege which we believe it has had no reason to regret. The Allahabad University itself is now

teaching a course leading to the M. Sc. degree in Agricultural Botany, which some of the members of the staff of the Agricultural Institute have had the privilege of helping get started by teaching certain portions of the course.

In 1936 the Institute also launched a new programme in women's education, in that it started a course in Home-making for girls. Provision is now made by the Board of High School and Intermediate Education of this province for an Intermediate course in Home Economics, and this is being taught at the Institute. Girls from all over India are taking advantage of this course.

The Institute made another move forward when in 1942, it started a new course in Agricultural Engineering, for the successful completion of which a B.Sc. degree is awarded by the Allahabad University. This is probably the only institution in the whole of Southern Asia giving such a training. The two batches of graduates, who have completed this course, are very much in demand to meet not only the war time exigencies but also the needs of the country in its post-war long term policies.

Another big step forward is being made by the Institute in inviting other Christian denominations to unite in making the Institute an all-India institution for serving the agricultural and rural needs of this country. Sufficient progress has been made towards this co-operation in America as well as in India, that we are very hopeful that in a few years the service rendered by the Institute will be greatly increased. In working this out we are being helped by a growing conviction in America that this is one of the ways by which that country can show its spirit of good will to this country. The Institute is also being helped in the carrying out of these plans, firstly by the appreciation of Governments, both provincial and Central, of the good work that the Institute is doing for the agricultural progress of the country by giving us grants for the expansion of our various departmental activities; and secondly, by the Indian public which have contributed financially to the Higginbottom Recognition Fund, a fund raised in this country as well as in America, in recognition of the very meritorious services of our retired Principal, Dr. Sam Higginbottom, and Mrs. Higginbottom, who served this country for a period of about forty years. This fund is making it possible to complete some of the class room and hostel buildings which have been planned in the new programme of expansion of the Institute.

As the Institute enters into this new era of expansion in order to be more useful to post-war India it has also stated as its policy the starting of a new department of extension which will help to carry the results of re earch and study, in the field of agriculture and rural life, into the villages of India. While this will be a new development, the idea is not new with us; as this has been one of the cherished desires of the Institute, and although not much has been possible in the past, the programme is to be greatly enlarged as soon as funds and personnel are available. We understand that both these are being provided to the extent that we can now make a start at the larger scheme.

## REPORT OF THE DEPARTMENT OF HORTICULTURE, 1944-45.

By

W. B. Hayes.

Fruit growing continued to be profitable as a commercial venture, but because of lack of staff and materials, very little experimental work was done during the year. Mr. A. Dayal Chand, who was helping in the department of Biology during the absence of Dr. E. F. Vestal, was expecting to devote more time to research after the welcome return of Dr. Vestal in June, 1945, but at about that time was asked to take up important work elsewhere, and resigned from the Institute.

There is ample opportunity for investigation in diseases of fruit by Dr. Vestal. The papaya crop on about five acres was auctioned to a contractor for Rs. 9,000, but because of disease much of the fruit was spoiled, and the price was reduced by Rs. 500. Although this left the crop profitable, it was a serious loss, and might have been prevented had the disease been promptly identified and protective measures taken. During the summer the orchards suffered from a lack of irrigation, as the supply of sullage water by the Municipality was only a fraction of the contracted amount. This, combined with the disease, led to the death of so many trees that all were removed which had borne more than once, and less than half of the latter are left. This means there will be a very small crop in 1945-46.

Gummosis has continued to cause loss in the grape fruit trees, and there was another outbreak of wither-tip in the citrus orchard, mainly on seedling sweet oranges. As this disease is supposed to cause serious damage only in regions near the Himalayas, or in badly neglected orchards, its occasional appearance in rather serious form in the Institute orchards suggests the possibility of a different strain of the fungus than that ordinarily occurring.

The *Cephalospora* disease of the guava has continued to spread, both at the Institute and in neighbouring orchards. The removal of trees soon after the disease has appeared has failed to stop the spread of the disease, but the practice is being continued, and an effort made to discover and remove the affected trees more promptly. The seriousness of the disease is indicated by a remark by a student closely connected with fruit growing in this district. He said that although the experiment at the Institute had clearly indicated that trees planted 25 feet apart produced much more fruit per acre than those 15 feet apart, it might be bett r commercial practice to plant trees 15 feet apart because most orchards were now removed when eight or ten years old, largely because of this disease.

Insects continue to cause troublesalso, among the most troublesome being the bark-eating caterpillar. This has become abundant in the phalsa and jujube trees, where it is difficult to eradicate. Mealy bugs again appeared in numbers on several kinds of fruit in the spring of 1945.

Larger pests are also very serious, and are also very difficult to control. Porcupines destroy germinating mango seedlings, and also cut off young papayas a few inches from the ground. Parakeets, crows and other birds, and fruit-eating bats are a constant menace to guavas, papayas, and other soft fruits. An effort has been necessary to educate the public to eat grape-fruit, but the parakeets have learned by themselves. In the first few years when grapefruit were being produced on the farm, the parakeets left them alone, but recently they have started eating them. As these animals and birds cause tremendous damage to other crops, such as wheat, rice, and maize, and as the individual farmer can do little to protect himself from them, it seems high time for Government to give serious consideration to this problem. Perhaps the first step would be to discover methods for controlling these pests.

Two varieties of tangelo ripened fruit in the winter of 1944-45 for the first time. The fruits were juicy, and of a pleasant flavour, but were lacking in acidity in the opinion of several who tasted them. This was surprising, for in the United States most tangelos are rather tart. Three other varieties have set fruit, and this will be watched with much interest.

# REPORT OF THE AGRICULTURAL ENGINEERING DEPARTMENT, 1944-45.

By

MASON VAUGH.

In April, 1944, Mr. Vaugh proceeded on furlough and Mr. Strong took over as officiating head of the department and continued till July 1945 when Mr. Vaugh returned. On completion of their examinations for the B. Sc. Agricultural Engineering, (in which both got first Divisions), Mr. M. K. Nandy reverted to his teaching duties and Mr. S. C. Bhatnagar took up teaching in the department, having been previously on research activities in another department of the Institute. Mr. R. D. Saxena continued through the year and Mr. G. L. Joneja till in February 1945, when he resigned to take up other work. Mr. R. S. Rao joined the staff and served through the academic year, resigning at the close of college, in April.

During the year, Messrs. B. D. Sharma, A. S. Negi, E. J. W. Moraes, and A. K. Bhatnagar served varying periods as research assistants on agricultural implements. Mr. Moraes left to take a commission in the army, Messrs, Sharma and Negi to take positions with commercial firms. Messrs. P. K. Bhargava and B. K. Mukerji continued through the year as research assistant on the bullock draft power scheme, Mr. Bhargava transferring to the Animal Husbandry and Dairying Department of the Institute at the end of the year.

On the commercial side of its activities, the Department lost the services of the workshop supervisor, the building mistry-overseer, and the whole office staff of bookers, which seriously disrupted the work at a time when it was already disrupted by changes of staff in the teaching and higher supervisory staff. Commercial activities, particularly the building of implements, was also greatly restricted by lack of workmen and of materials, particularly steel. Skilled iron workers especially those with any knowledge of implements, were particularly in short supply, many of the trained men from the workshop having gone into various war activities.

Mr. Vaugh returned from furlough in early July and resumed charge of the Department. Mr. M. K. Nandy was transferred from teaching duties to the post of research engineer in implements. Mr. S. S. Bhatnagar joined as teacher of mathematics and physics, Mr. A. K. Bose as teacher of certain civil engineering subjects and Mr. Jagdish Narain as teacher of certain mechanical engineering subjects. Mr. M. H. Khan who got a first division in Agr. Engineering in 1945, was employed temporarily in expectation of his going abroad for advanced study. He and Mr. Nandy have both been awarded Government scholarships and will proceed as soon as arrangements are completed.

As indicated above, the activities of the department other than carrying on the routine teaching, were severely handicapped by conditions. Some implements were made and sold, but there is still a large backlog of orders unfilled and additional orders being received steadily with no sales promotion going on. No major building was constructed during the year, though various smaller structures including extensions to the Animal Husbandry barns and feed store, facilities for the pig scheme, and a temporary dining hall for the hostel pending completion of the new hostel, were built. At the time of writing of this report, a block of five quarters in connection with the new Dispensary building is under construction and resumption of building on the new hostel is planned for the near future.

Recently, more skilled labour is becoming available and active making of implements has been resumed. Steel is more available also. Several hundred ploughs have been despatched and it is expected that several hundred a month will be despatched for several months at least. The manufacture of more

complicated implements has had to be suspended but it is hoped to resume the making of seed drills, at least, in the near future. The demand for implements is growing steadily and seems likely to continue to grow.

Arrangements for improving the equipment of the department were made during the year, though the new machines have not yet begun to arrive. A new lathe, a 40 ton press, a drill press, a flexible shaft grinder, and an electric welder are on order through the Machine Tool Controller and are expected soon. Another lathe, a radial drill, a drill press and another smaller welder have been given and are en route to India from America. Various other machine tools and equipment has been promised when available after the war. These various machines will greatly improve the equipment for teaching and also for manufacture of implements. It is hoped that the teaching equipment will be so improved that we can take at least double the number in the Agr. Engineering degree classes and possibly a full section. The provision of buildings for other departments through the Higginbottom Recognition Fund, will release space in the Engineering building for better arrangement of laboratory facilities.

The development of new implements has been held up by preoccupation of the staff with other duties and hampered by the frequent changes in the research staff. However, work is in progress on a 3-row seeding attachment for the Shabash and Wahwah cultivators, on a one-row wheeled type cultivator for interculture, on a mulcher for rabi seed bed preparation, and on the bullock gear driven chaff cutter started some time ago. Testing of implements and development of farm practices on the "rainfed farm" of the department has continued. What appear to be valuable results seem to be shaping up but we wish to test them another season or two before announcing final conclusions. Work in the current season was hampered by the relatively unfavourable rains and by poor germination of the seed available.

A research problem is being set up cooperatively between the Engineering Department, the Agronomy Department and the Biology Department for a study of the factors affecting the viability of stored seeds. Seeds, particularly those of the kharif crop, will be dried by artificial ventilation, examined for fungus and other parasites tested for germination and stored under different conditions. The object will be to determine the factors which under Indian conditions lead to poor germination and the conditions necessary in a seed store to ensure viable seed. Preliminary tests will be made in the fall of this year and will probably need to be continued for several more years before they will give final results.

## REPORT OF THE HOME ECONOMICS DEPARTMENT, 1944 45.

By

Mrs. John L. Goheen.

The Home Economics Department rejoices in a very fine staff this year. Last April the prospects seemed dark. The department had lost not only Mrs. Higginbottom, but Miss Hoffman and Mrs. Warner (M.Sc. and B.Sc., Home Economics, respectively) as well There was no certainty of replacements arriving in time for the opening of college. The resident teacher, Miss Benson, was married at the end of the year.

However, a new resident teacher, Miss Esther Paranjoti (M.A., English) was first secured. In June, Mrs. Vestal, teacher of Economics, arrived from the U.S.A. In July, and in time to begin the year, came Miss Hattie Brooks (B.Sc. Home Economics) our new short termer, and at the same time Mrs. Vaugh, specialist in Handicrafts. Miss Miriam Null (B.Sc., Home Economics) of Nanking, China, then joined our staff for the year, or until she can return to her work in China. With Mrs. Azariah (B.Sc., Home Economics) there are now three full-time Home Economics graduate on the staff. Add Mrs. W. S. Gould,

teaching Home Decoration, and the fine men staff of the Institute, and the H.E.D. has the strongest staff it has ever had.

There are fifteen students—eight in the I year and seven in the II year. Like the men students, the girls come from various parts of India and so thus continue the all-India character of the Institute.

There has been an attempt to improve the grounds surrounding the H. E. D. hostel, by planting lawns, borders and a hedge which will in time give dividends of beauty and privacy.

A greater measure of self government has been introduced.

The Day Nursery, for the children of women workers on the farm, is being successfully run this year by Mrs. Strong and her able assistant, a last year's graduate, Miss Virginia Arthur, until she leaves for England on a scholarship. Classes in Child Care use the nursery for observation.

Girls take turns in giving talks and demonstrations on hygiene every Saturday to the adult literacy classes for women which meet on Mrs. Vaugh's verandah.

Games, Garden, Social life, Student Christian Movement and Social Service League are all going strong at the time of writing. We seem to be all set for a very happy and successful year.

---

## REPORT OF THE DEPARTMENT OF BIOLOGY, 1944-45.

By

E. F. Vestal.

The active staff of the Department of Biology for academic year 1944-45 consisted of Mr. W. K. Wesley, officiating Head of the Department, Mr. A. Dayal Chand (plant pathology), Mr. S. R. Barooah (agricultural botany and bacteriology) and Mr. L. A. Nott (botany and zoology). Mr. T. A. Koshy left in the Fall of 1944 on a two year leave to take up post-graduate study in the United States, Mr. S. R. Barooah and Mr. L. C. Nott taking over his duties. Mr. Barooah also took over the bacteriology class, thus relieving Dr. T. W. Millen for essential work in the Animal Husbandry and Dairy Department. Mr. A. Dayal Chand resigned from the Institute at the end of the 1944-45 year to accept a position elsewhere. Mr. W. K. Wesley was given leave at the end of the 1944-45 season to continue and finish his work for the doctorate degree in the University of Allahabad. Edgar F. Vestal returned from furlough in the United States to resume the position as Head of the Department of Biology, but had no part in the departmental activities of the 1944-45 academic year. The departmental reports will be given by Mr. W. K. Wesley and Mr. S R. Barooah.

Besides the regular students, one special student received training in entomology during the year.

**Botany** (S. R. Barooah.)

As reported in 1943-44 a research scheme on the vernalization of paddy and certain vegetables was conducted under the auspices of the Harvard Yenching Fund. The experiment on paddy was conducted with 10 varieties. The varieties that were used were Bansmati, Jhalore, Local, T-136, A-64, Bansi, Devega, Jarwan, Sitachameli. The seeds were soaked for 24 hours and then were exposed to different temperatures, according to a design of the experiment. The seeds were treated at four different temperatures 6°C, 15°C, 20°C and room temperature. There were thus four different treatments. The seeds were treated for one month. They were then kept in a refrigerator for one month. After the seeds were treated for one month, the treated control seeds were sown in a nursery bed on the 22nd July. Every possible care was

taken for their good growth, but, unfortunately, before they could be transplanted one single heavy rain destroyed the whole crop, so there are no data to present; but this experiment will be carried out again in the next year. Along with the paddy experiment, research was also conducted on the possiblity of increasing the production and decreasing the life cycle of some of the vegetables by exposing them to different photoperiods up to the nursery stage. The vegetables used were cabbage, cauliflower, brinjal, chillies, tomatoes and lettuce. Some promising results were secured with brinjal, chillies, tomatoes and lettuce.

## Entomology (W. K. Wesley.)

The following are some of the remedies suggested to prevent the attack of insect pests in stored wheat and wheat flour. Apart from the difficulties of protecting wheat and its flour from the attack of rats and other rodents as well as termites it is a big problem to store them in large quantities over long periods because of attack of insect pests of stored grain. The young stages of several species of insects, along with the adults in most cases, cause a considerable amount of loss by eating and destroying the grain and its flour and making it unfit for use. The following beetles (*ghun*) along with the caterpillar of a moth are chiefly responsible for the damage caused to wheat and its flour at Allahabad and its neighbouring districts.

1. The rice weevil or *sund wala ghun* (*Calandra oryzae* L.)
2. *Khapra ghun*. (*Trogoderma khapra* Arr.)
3. The wheat weevil (*Rhizopertha dominica* F.)
4. The red grain beetle or *Lal ghun*. (*Triboleum castaneum* M.)
5. The grain moth. (*Sitotroga cerealella* Oliv.)

The life histories of these stored grain insect pests have already been reported in 1942.

Cleanliness is the key note to successful storage of grain. Before storing, the grain should be thoroughly sun dried. Old grain along with dust chaff, etc., should be removed, as far as possible, before the new grain is stored. The empty store room should be superheated with charcoal at the rate of 7 maunds per 1,000 cubic feet in order to kill any insects that may be hiding in the store room. Gunny bags ought to be also superheated or disinfected with boiling water for a quarter of an hour. Once a year the cleaning should be followed by general repairs to all cracks in the godown and painting if possible. Insect free grain should be brought direct from the threshing floor to the clean and insect proof godown in clean gunny bags.

When the grain has been stored and if it is found to be attacked it should be fumigated with carbon bisulphide at the rate of 1 ounce to 15 cubic feet of space or with hydrocyanic acid gas at the rate of 1 pound potassium cyanide, 1 pound commercial sulphuric acid and 3 pounds of water for 1,000 cubic feet of space. Great care should be taken in the performing of these operations for carbon bisulphide is highly inflammable and hydrocyanic acid gas is deadly poisonous.

If mercury is kept in the bin at the rate of 3 to 4 tolas to each maund of wheat in small (2″ × 2″) twill bags it will keep the grain safe. The bags are so kept in the bin as to allow about half of the total quantity of the mercury used to be present in the upper one foot layer. An amalgam of mercury with zinc can also be used which is prepared as follows:—Take three parts of mercury and two parts of zinc in a stone mortar and mix them well with a non-metallic pestle. Filter the free mercury through some fine muslin cloth and apply the amalgam between two blotting papers in a thick layer and wrap this preparation in some other paper. Then introduce this preparation about two inches deep in the stored grain. When the grain is required for use, this preparation can be

removed and the grain sun heated for a little while. This preparation will remain good for several years and can be used at the rate of one tola of the amalgam to twelve maunds of grain.

In the case of *khapra* in addition to the general methods of control, as suggested above, the adults and the larvae can be trapped by spreading the gunny bags on the grain and destroying the insects that gather on them.

REFERENCES:


1. Back, E. A. *United States Department of Agriculture Farmers' Bulletin* 1156, 1920.
2. Bhatnagar, S. C. Control of Insects infecting stored grain and other products. The Allahabad Farmer, Vol. XVI No. 3, 1942.
3. Kochak, T. S. Rahbar-i zarat p. 362, 1941.
4. Rahman, K. A. Observations on the reactions of the Dermestid beetle, *Trogoderma khapra* Arr. *Ind. Jour. Ent.*, Vol. I, Pts. I and II (1939): 57.
5. "Seasonal Notes" of the Department of Agriculture, Punjab, October, 1927.
6. Shepard, H. H. *University of Illinois Experiment Station Tech. Bulletin* 340, 1939.
7. Wellhous, W. H. How Insects Live, pp. 295-300, 1928.
8. Wesley, W. K. Some Insect Pests. *Zoological Soc. Bull.* No. III, 1941.
9. —— ——Report of the Department of Biology. The Allahabad Farmer, Vol. XVI, No. 5, 1942.


## REPORT OF THE DEPARTMENT OF AGRICULTURAL ECONOMICS, 1944-45.

By

H. S. AZARIAH.

This report covers the academic year commencing from the 1st of July, 1944 and ending in the 30th of June, 1945. Dr. Sam Higginbottom continued to be the Head of the department until he left us in March, 1945. The teaching in this department was done by me and Mr. L. C. Nott, as Dr. Higginbottom had other pressing demands on his time before he handed over the charge of the Institute to his successor, Dr. J. L. Goheen.

The department had to confine its activities to teaching only, as heavy teaching load and lack of personnel made it impossible to undertake any research. The Research Section of the Board of Christian Higher Education set aside Rs. 50 for an investigation of Christians settled on land to be carried on by me, similar to the one I had done the previous year. Naturally, this could not be done. The Indian Society of Agricultural Economics also kindly offered financial help: and again the opportunity could not be seized. In teaching Agricultural Economics, especially Farm Management, I am afraid no further progress can be made unless we find out certain economic conditions as they exist in this part of the country. We donot have even charts on labour distribution for various crops and livestock enterprises! We have the necessary data in the farm manager's office: but they are not in a form that can be conveniently used for teaching. The data have to be analysed and charts and tables have to be made. Similarly, we do not have a single chart on Price Trends. I am confident that this department can contribute a great deal in the field of agricultural economics, if it can undertake research work. It is hoped something could be done at least next year.

## REPORT OF THE CHEMISTRY DEPARTMENT, 1944-45.

By

A. P. Brooks.

*Staff* :—During the year under report the staff remained much the same as the previous year :—Mr. A. P. Brooks, Head of the department; Messrs C. O. Das and J. C. Gideon, teachers ; and Mr. N. C. Newton was employed as demonstrator during part of the year. Dr. B. B. Malvea, Principal of Ewing Christian College, continued to teach B. Sc. classes in theoretical Agricultural Chemistry. Mr. Brooks officiated as Treasurer of the Institute all through the year and as a consequence was not able to give much time to the Chemistry department. He taught a few classes, but most of the day by day supervision was handled by Mr. Das. Mr. Newton's departure during the middle of the year caused a shortage of staff which created difficulties.

*Supplies* :—The supply situation has not improved to any extent during the year. It has been difficult to get all of the chemicals and glassware needed for regular laboratory work, and research work has been even more hard hit. Some exercises had to be discontinued, but most of the regular work went along inspite of supply problems.

*Activities* :—As usual, most of the work done by the department is routine teaching, both theory and practical. There are altogether eight different classes to be given both theoretical lectures and practical work.

The department is often called upon to help some other department or to undertake various investigations. This year has been no exception, but the shortage of staff and supplies has to some extent limited what could be done along this line. Samples of milk, butter, fats, feeding materials and fertilizers have been tested. Chemicals and drugs suspected to be impure have also been tested and in several cases gross adulteration or complete substitution has been found. For example citric acid purchased for use in jelly making and fruit preservation was found on testing to be an entirely different compound, potassium bisulphate. The attention of the suppliers was called to this form of cheating, and fresh supplies of pure citric acid eventually obtained.

## REPORT OF THE AGRONOMY DEPARTMENT, 1944-45.

By

B. M. Pugh and S. R. Misra.

### STAFF (B.M.P.)

During the year several changes took place in the teaching staff. Early in the year Mr. A. N. Singh joined the staff in order to teach Agronomy classes to Intermediate students. When a new short course in agriculture was started in co-operation with Government for Indian soldiers, Mr. A.N. Singh was transferred to this course, and Mr. H. G. Gupta was recruited to take his place. Early in the year the University of Allahabad also opened a new M.Sc. class in Agricultural Botany and asked for the part time services of Mr. B.M. Pugh for teaching Genetics and Plant Breeding to the new class. In order to comply with this request the Institute had to transfer Mr. S. R. Barooah from the Biology Department, to the Agronomy Department to take care of some of the classes which Mr. B.M. Pugh had to give up in order to enable him to teach university M.Sc. class.

The Farm staff also lost this year the services of Mr. G. Q. Vachoo who resigned and returned to Kashmir.

## RESEARCH AND EXPERIMENTATION (B.M.P.)

The department continued its programme of research and experimentation which had been reported in previous years, the main objective in this being the selection or evolution of varieties of crops most suitable for this locality.

*Sugarcane*:—The work on sugarcane was started in 1942-43 in co-operation with the United Provinces Department of Agriculture. We started out with 9 varieties, namely, Co. 313, Co. 331, CoS. 146, CoS. 5, Co. 312, Co. 393, Co. 421, CoS. 76 and Co. 527, which were selected by us on the basis of their performance elsewhere in the province. As the result of our experiment in 1942-43, varieties CoS. 146 and CoS. 5, were dropped because of their poor performance. In February, 1944, on the basis of our observation of the standing crop in the field, these four were selected out of the remaining seven for a randomized block experiment: Co. 331, Co. 312, Co. 313 and Co. 421. After harvesting the crop in March, however, we found that Co. 393 and Co. 527, which were discarded, might also have been included in the experiment. The record of their yields was given in the September 1944 report of the department.

The sugarcane varietal experiment in 1944-45, therefore, consisted only of four varieties. The experiment was again a randomized block lay-out of six replications. The size of each plot was $27' \times 76'$, and the block size was $108' \times 76'$. The experimental plot size after removing border rows and three feet at each end of the plot was $21' \times 70'$. The total yields of the varieties in seers were as follows:—

| Co. 313 | Co. 331 | Co. 312 | Co. 421 |
|---|---|---|---|
| 6555·0 | 5907·0 | 5391·0 | 4541·0 |

The lines underneath the yields of cane indicate the group in which there was no significant difference when the results were analysed statistically. These results as well as our observations of the crop during the period of experimentation would seem to show that Co. 313 should be preferred to the others as a field cane. Besides the yields reported above it was also observed that Co. 331, Co. 313 and Co. 421 were practically of the same class in their resistance to lodging, whereas Co. 312 was very susceptible to it. Co. 313 also showed greater resistance to drought than the other three. It was also somewhat resistant to red rot, whereas Co. 312 was very susceptible to it.

*Paddy*:—A randomized block experiment was laid out in which the following eight varieties were included, namely, Lejura Jhalore, Jarwan, T. 1., T. 136, Badshah, No. 17 and Bansi. Of these Jhalore, Bansi, T. 1 and T. 136 were selected out of the six varieties that were experimented on in 1943-44; the other two, Local and A. 64, were dropped. On the other hand, 4 new varieties, Badshah, Jarwan, Lejura and No. 17 were included this year, as their performance in the small plots in the previous year indicated that they were promising varieties. The yields of paddy of this year's experiment were :—

| Jarwan and No. 17 | Lejura | Jhalore | Bansi | T. 1 | T. 136 | Badshah |
|---|---|---|---|---|---|---|
| 69·5 | 67·0 | 65·0 | 53·5 | 40·5 | 24·5 | 12·0 |

These results confirm our conclusions arrived at the previous year, namely, that certain local varieties of rice, such as Jhalore, Jarwan, Lejura and Bansi, are superior to the "improved" types, T. 1 and T. 136, as far as their money value to the cultivator is concerned. The results this year, however, seemed to indicate that No. 17, a Government sponsored variety, is of the same class as the local varieties. Observations on earliness of these eight varieties gave the following results :—

| Badshah | T. 1 | T. 136 | No. 17 | Lejura and Jarwan | Bansi and Jhalore |
|---|---|---|---|---|---|
| 30 | 23 | 22 | 18 | 12 | 11 |

That is, Badshah is a very early variety; T. 1 and T. 136 are early, speaking comparatively; No. 17 is medium early; and Lejura, Jarwan, Bansi and Jhalore are late ones. Earliness is a quality which may be considered very desirable for paddy if the field in which paddy is grown is going to have a rabi crop such as wheat following it the same year. While we have been able to grow wheat after harvesting the paddy experimental plots, there has been some delay in sowing because of the late-ripening varieties. For such conditions, No. 17, as a result of this year's experiment, might be considered very suitable. Even T. 1 may be preferred because of earliness for such conditions in place of Jarwan, Lejura, and Jhalore which had outyielded it.

*Arhar* (*Cajanus indicus*):—Selecting the best two varieties out of the six included in the experiment the previous year, and introducing one new variety which was obtained from a local fair (Magh Mela), we conducted a varietal experiment, the layout consisting of 6 randomized blocks, of three plots each. The size of each plot was 85′ × 18′. The experimental plot size after removing 2 border rows and 3 ft. at each end in order to eliminate border effects was 79′ × 15′. The following results were obtained in the yields of grain:—

| I. P. 80 | Local | Magh Mela |
|---|---|---|
| 136·5 | 133·5 | 40·5 |

These results again indicate that there is no preference between I. P. 80 and Local. The yields of the previous year for I. P. 80 and Local were 212·05 and 205·65 respectively. The results also indicate that the Magh Mela variety is very inferior in its yielding capacity.

*Juar*:—(*Sorghum vulgare*)—Leaving out 8 B and T. 9 which were the poorest last year, only 5 Tall, D. D. Yellow, Malwa and D. D. White were included in a randomized block experiment, the layout consisting of 6 blocks of 4 plots each. The size of each plot was 15 × 80; but the experimental plot size after removing two border rows and 2½ feet at each end of the plot was only 10′ × 75′. The total yields of grain of the 4 varieties in seers were as follows:—

| D. D. Yellow | 5 Tall & D. D. White | Malwa |
|---|---|---|
| 74·5 | 7·20 | 66·0 |

The total yields of fodder were as follows:—

| D. D. White | 5 Tall | Malwa | D. D. Yellow |
|---|---|---|---|
| 564 | 514 | 510 | 487·5 |

The statistical analysis showed that there was no significant difference in the yields of the above four varieties. This again confirmed the results obtained the previous year. D. D. Yellow and D. D. White are local varieties, 5 Tall is a U. P. Government variety and Malwa is a variety from the Malwa plateau in Central India.

*Bajra* (*Pennisetum typhoideum*):—Leaving out T. 11 and Allahabad 6 as the result of the experiment the previous year, and introducing another local variety which was selected for the hairiness of the ear, we had this year 4 varieties in a randomized block experiment. The layout consisted of 6 blocks of 4 plots each, the size of the plot being 18′ × 47′ which became 15′ × 44′ when two rows on each side and also 1½ feet at each end of the plot were removed for border effects. As block III did very poorly because of poor drainage, this was later left out so that the results of only five blocks were taken into consideration in the analysis of the data. The results of the total yields of grain of the 4 varieties were as follows:—

| Local | Alld. Hairy | Alld. 4 | T. 16 |
|---|---|---|---|
| 42·5 | 41·5 | 38·5 | 33 |

The total yields of fodder of these four varieties were, in seers, as follows:—

| Alld. 4 | Local | Alld. Hairy | T. 16 |
|---|---|---|---|
| 448 | 395·0 | 391 | 378·5 |

Although there was no significant difference in the yields of the varieties when the data were statistically analysed, yet it appears that there would be no improvement in the introduction of T. 16 to the Allahabad area.

*Gram* :—The test of the six varieties of gram which were included in the experiment in 1943-44 was repeated this year. The layout was a randomized block of 6 replications with 6 plots in each block. The size of the plot was 12' × 48', but which became 10' × 46' after removing 2 border rows and 1 foot at each end of the plot in order to eliminate border effects. The total yields of gram of the varieties, in seers, were as follows :—

| I. P. 58 | Local and I. P. 56 | I. P. 17 | Indore 4 | Indore 707 |
|---|---|---|---|---|
| 61·5 | 55·0 | 51·0 | 48·5 | 45·5 |

The results this year considerably advanced the position of I. P. 58 and somewhat lowered the position of Local from what it was the previous year. The Indore varieties, as the result of this as well as last year's experiment, would seem not suitable for this area.

*Barley* :—Six varieties were tested this year in a randomized block experiment. These were Local, T 20, I. P. 21, 300 A, C. 251 and 35/24. Of these all but the last had been included in the experiments on barley varieties in previous years, a full report of these experiments having been made in the Allahabad Farmer, Vol. XVII, No. 4 and in the report of the Agronomy Department in the September 1944 issue. The variety, 35/24 included for the first time in a randomized block experiment was sent to us by the Economic Botanist (cereals) of this province. The layout consisted of six blocks of 6 plots each, the size of each plot being 12' × 48'. The experimental plot size was 10' × 44' after the removal of 2 border rows and 2 feet at each end of the plot in order to remove border effects. The total yields of grain in seers of each variety were as follows :—

| T. 20 | 35/24 | I. P. 21 & 300 A | Local | C .251 |
|---|---|---|---|---|
| 66·75 | 64·75 | 63·50 | 61·75 | 60·75 |

The yields of straw of the varieties were as follows :—

| T. 20 | I. P. 21 | 35/54 | 300 A | C. 251 | Local |
|---|---|---|---|---|---|
| 132·25 | 122·50 | 114·75 | 112·5 | 111·0 | 81·75 |

*Wheat* :—The department continued its co-operation this year with the Botany Department of the University of Allahabad in testing the irradiated wheats of Dr. Shri Ranjan of the University. A report of the experiment on these wheats will be published in full later.

*Manurial Experiment* :—Besides the above varietal tests, the department, also, had this year a manurial experiment in which the value of blood meal as a fertilizer was sought to be determined. Ammonium sulphate, castor cake, blood meal, and a control, were taken as the four treatments in a randomized block experiment with juar. The amount of each of the fertilizers applied was 60 lbs. of nitrogen per acre. The layout consisted of six blocks, each of four plots, the size of each plot being 16' × 98'. The experimental plot size was only 12' × 94' after the removal of two border rows and 2 feet at each end of the plot. Ammonium sulphate was applied in two doses during the early stages of the growth of the crop, but castor cake and blood meal were applied only at one time a few days after the crop had germinated. The result of the experiment may be judged by the following data on the yield of grain and of the dry fodder of the four treatments.

Total yield of grain in seers of each treatment :—

| Ammonium Sulphate | Castor Cake | Blood Meal | Control |
|---|---|---|---|
| 180·5 | 176·5 | 172·0 | 154·0 |

Total yield of dry fodder in seers :—

| Ammonium Sulphate | Blood Meal | Castor Cake | Control |
|---|---|---|---|
| 1101·5 | 1064·5 | 1038·5 | 992·0 |

The results would indicate that blood meal is as good a fertilizer as castor cake although it may not be as readily available as ammonium sulphate to the growing crop.

## Demonstration (S. R. M.)

The change in the weather became noticeable from the third week of June, 1944, giving hopes of a timely start of the monsoon ; but a really good rain (2·27″) did not come until July 6th. Thus the planting of *kharif* (monsoon) crops was delayed. The rains in July and August were not only almost constant but also fairly heavy. The rain in August was above the normal by 6″. September also was rather cloudy and the rainfall in the month (5″) was about the same as normal. Thus the *kharif* crops encountered unfavourable weather conditions during their growing season.

Harvesting of the main fodder crop (*juar*) had to be delayed, which, in turn, delayed the seed-bed preparation and the sowing of *rabi* (winter) crops. The seed-bed preparation of a considerable part of the area planted to wheat was not satisfactory ; and also a considerable area had to be left unplanted. The late rains of September and the early rains of October (1·4″) were helpful in providing necessary soil moisture for the *rabi* sowing. However, these rains proved injurious to the potatoes which were planted a little earlier this year. Also an attack of cut worms later caused much loss in the yield of early potatoes. Likewise, a precipitation of two inches during the first ten days of January while good for *rabi* cereals and fodders, was harmful to potatoes. About the same time an accident occurred in the local municipal sullage pumping station. This resulted in the running of one pump only, supplying a daily average of 30 to 50 thousand gallons of sewage from January to March, when needed most for potatoes and many vegetables, whereas the Institute had been getting up to 3 lac gallons daily. The only thing to do with potato was to save by all means the promising plots and to watch helplessly the drying up of others. As a result, there was a severe loss on the potato crop and acute divergence in the yields of individual plots. The average yield of early potatoes was 69 maunds an acre, ranging from the lowest yield of 21 maunds to the highest yield of 180 maunds. The average yield of hill potatoes amounted to 90 maunds an acre, ranging from 20 maunds to 252 maunds.

Most of the other vegetables were planted on the tube-well irrigated area in which the soil was still poor. The pumping system also failed for a short time more than once.

All the vegetables including potatoes were bonded under the Government Vegetable Scheme in which the cost of preparation for delivery was high ; and at times certain vegetables at their best were not called in by the Vegetables Supply Unit.

The yield of wheat came down to an average of seven maunds only. Two-thirds of the wheat was on unirrigated area and the remaining one-third could be irrigated only inadequately. The production of fodder also was not satisfactory. It consisted chiefly of Napier grass and indigenous grasses. These brought us through the year by furnishing the fodder supply for our cattle of about 600 head, and that, at one-third to one-half the market price for fodders.

The employment of labour rose over last year by 21 per cent and the cost of labour by 38 per cent.

The factors stated above and some others of a similar nature have led to considerable diminution of the farm surplus in comparison with that of the previous year.

**Acknowledgment.**

We are grateful to the following students in Agronomy who analyzed the data mentioned in this article thus giving us the values of the significant difference : G. P. Das, G. K. Jain, S. M. Verma, A. K. Ghosh, B. Pisharodi, B. K. De, and A K. Das Gupta ; and to our assistants, B. K. Sahu and G. D. Singh, for checking their calculations.

---

# REPORT OF THE DEPARTMENT OF ANIMAL HUSBANDRY AND DAIRYING, 1944-45.

By

T. W. MILLEN, M. Sc., D.V.M.

## PERSONNEL

| | |
|---|---|
| Dr. T. W. Millen. | Professor of Animal Husbandry and Dairying ; Department Head. |
| Mr. J. N. Warner. | Associate Professor of Dairying ; Dairy Manager. |
| Mr. N. R. Joshi. | Associate Professor of Animal Husbandry. |
| Mr. E. C. Bartley. | Lecturer. |
| Mr. I. N. Mathur. | Lecturer. |
| Mr. Qutubuddin. | Lecturer. |
| Sardar Singh Bhatia. | General Supervisor in Animal Husbandry. |
| Mr. T. R. Nikam. | Dairy Supervisor. |

Mr. K. Das Gupta took over charge as Dairy Supervisor on September 4th when Mr. Nikam resigned to take the post of Dairy Manager at the Captain Rai Sahib Kripa Ram Dairy, Mhow.

Mr. Bhatia returned to the Institute after thirteen years in the poultry and goat farm at Etah. He became general supervisor of the expanding enterprises of the Animal Husbandry section.

Mr. Bartley secured a scholarship for Graduate study at Iowa State College, Ames, Iowa, U. S. A. and resigned his post here in March.

## MILK & MILK PRODUCTS (T. V. R.)*

The sale of milk and milk products has been steadily increasing during the past year and the figures are shown in Table I. Sales by months are indicated to show the variations from month to month for each product. The totals for the previous year are included for comparison.

*Mr. Iyer became Dairy Manager in July, 1945.

TABLE I.

*Sale of milk and milk products from April,* 1944 *to March,* 1945
*(Figures in pounds and ounces.)*

| Month. | Milk. | Butter. | Dahi. | Cream Cheese. | Cream. | Ghee. | Ice Cream. | Cheddar Cheese. | Daily average for milk. |
|---|---|---|---|---|---|---|---|---|---|
| April .. | 19956-0 | 2912-12 | 186-8 | 109-4 | 71-0 | 97-8 | 3761-0 | 677-6 | 665-3 |
| May .. | 18266-0 | 2360-6 | 244-0 | 53-0 | 13-4 | 12-12 | 3414-8 | 397-2 | 589-3 |
| June .. | 15249-0 | 2305-10 | 252-8 | 54-0 | 7-12 | 35-10 | 2917-0 | 320-4 | 508-5 |
| July .. | 21386-8 | 2289-10 | 302-0 | 78-4 | 16-6 | 30-8 | 1664-0 | 594-14 | 689-14 |
| August .. | 23453-0 | 3268-10 | 284-0 | 55-8 | 6-14 | 3-8 | 1055-0 | 502-14 | 756-1 |
| September .. | 22539-8 | 3573-12 | 236-8 | 16-8 | 17-2 | 14-2 | 1176-0 | 636-10 | 751-5 |
| October .. | 22522-8 | 3761-10 | 117-0 | 3-14 | 44-8 | 22-0 | 1046-0 | 273-6 | 726-8 |
| November | 23597-8 | 3602-10 | 120-0 | 30-4 | 73-14 | 4-6 | 950-0 | 642-4 | 786-9 |
| December .. | 23007-0 | 3305-4 | 40-6 | 40-14 | 42-6 | 17-0 | 738-8 | 631-8 | 742-2 |
| January .. | 21761-0 | 1980-12 | 35-0 | 3-0 | 35-8 | 25-12 | 438-0 | 763-6 | 701-15 |
| February .. | 23725-8 | 783-4 | 58-0 | 0-12 | 32-12 | 20-10 | 555-0 | 388-10 | 847-5 |
| March .. | 27312-0 | 705-6 | 162-0 | 2-8 | 31-2 | 3-38 | 1850-8 | 444-8 | 881-0 |
| Total .. | 262775-8 | 30849-10 | 2037-14 | 447-12 | 392-8 | 317-4 | 19565-8 | 6272-12 | 719-15 |
| Previous year Total .. | 215234-0 | 2768-5 | 4289-0 | 959-10 | 282-10 | 40-2 | 26737-0 | 3887-7 | 588-1 |

Milk sales were highest in March and lowest in June. The difference in the daily average of the two months was 372-7 pounds. Normally the lowest sales occur during the months of May and June owing to the closing of schools and colleges. There is a remarkable increase in the sale of fluid milk as compared to the previous year. The demand for fluid milk was very great. Much of the milk previously fed to calves was sold as bulk milk and the calves received a milk substitute (blood meal).

Butter sales varied from 3573-0 pounds in September to 705-0 pounds in March. The sudden drop in the sale of butter from the month of February is due to the stoppage of supply to Calcutta. This is mainly due to the climatic variation. The butter melts and naturally there is a fall in sale. Efforts are being made to introduce ice boxes, with the help of which butter can be sent to far off places. The total sales, however, has been increased considerably from that of the previous year. The demand for butter increases from the month of July to October. To meet the growing demand for butter, cream has to be purchased from other sources. The total milk obtained from the cattle yard for the creamery for the year is 4,06,959 pounds, out of which 2,69,444 were sold in the form of fluid milk. The remaining portion of the total milk was utilized for the Manufacture of milk products. During the current year 2,682 pounds of cream were supplied by the cattle yard. Cream obtained from other sources amounts to 43,658 pounds. A cream supply that would rise and fall with the butter demand is the only remedy to meet the demand of butter economically. Supervised control of the calving season is another measure for which the cattle yard is taking all possible measures.

Dahi has a seasonal demand as indicated by the sudden rise in sales to 302 pounds in July. In January the sales came down to 35 pounds. Sales of dahi are low in the winter season and high in summer.

There is a decrease in the total amount of sale of Ice Cream as compared to the previous year. This is due to the inability of getting new machines, and the old ones required constant repair. Our ice plant also failed at the time it was needed most.

The sales of Cheddar Cheese do not show the total demand for this product, but they indicate the amount that it was possible to handle with the amount of milk available. From the sales received it can be seen that the quality of cheese has been approved and highly appreciated by many of the customers.

## MILKING STOCK

During the year under report we sold more cattle than ever before, and still turned over to the dairy the largest amount of milk in the history of the Institute. Seventy-four cows and buffaloes were sold during the year and five died. Forty-eight heifers freshened during the year. We have raised a higher per cent of our calves in recent years making it possible for us to cull our herd rigidly each year. Table II shows the breed-wise distribution of our milking herd.

TABLE II

*Milking Stock.*

| Serial No. | Breed | Number on 1-4-44 | Transferred from Female Young Stock | Sold | Died | Number on 1-4-45 |
|---|---|---|---|---|---|---|
| 1 | Red Sindhi .. .. | 42 | 7 | 11 | 1 | 37 |
| 2 | 1/8 Jersey x Sindhi .. | 3 | 5 | 2 | 1 | 5 |
| 3 | 1/4 Jersey x Sindhi .. | 28 | 15 | 11 | .. | 32 |
| 4 | Jersey x Sindhi .. .. | 17 | .. | .. | .. | 17 |
| 5 | Jersey .. .. | 3 | .. | 1 | .. | 2 |
| 6 | 1/8 Holstein x Sindhi .. | 10 | 4 | 8 | .. | 6 |
| 7 | 1/4 Holstein x Sindhi .. | 5 | 1 | 3 | .. | 3 |
| 8 | 3/8 Holstein x Sindhi .. | 1 | .. | .. | .. | 1 |
| 9 | 1/8 Brown Swiss x Sindhi .. | 3 | 2 | 3 | .. | 2 |
| 10 | 1/4 Brown Swiss x 1/4 B. S. Hariana .. .. | 17 | 1 | 7 | .. | 11 |
| 11 | 1/2 B. Swiss-Sindhi x ½ B. Swiss-Hariana .. | 6 | .. | .. | .. | 6 |
| 12 | Miscellaneous .. .. | 14 | 9 | 13 | .. | 10 |
| 13 | Murrah-Buffalo .. .. | 37 | 4 | 16 | 3 | 22 |
| 14 | 1/16 Jersey x Sindhi .. | .. | 1 | .. | .. | 1 |
| | | 186 | 48 | 74 | 5 | 155 |

Table III shows the lactation averages for the milking herd. This year again the Jersey-Sindhi crosses were the best producers as a group. Our Red Sindhi averaged well above the requirement for registration in the central Herd Book (2,500 pounds in 300 days).

The following statement shows the performance of those animals which completed their lactations during the year 1944-45.

| Breed. | No. of lactations completed | Average yield lbs | Average days in milk. | Average days dry preced-ing. | Daily average during milking | Over-all daily average period. | No. on 1st. lac-tation heifers. |
|---|---|---|---|---|---|---|---|
| Red Sindhi .. | 24 | 2768·82 | 293·6 | 138·9 | 9·43 | 6·49 | 5 |
| 1/8 Jersey-Sindhi .. | 1 | 5051·9 | 363 | 67 | 13·91 | 11·7 | .. |
| 1/4 Jersey-Sindhi .. | 12 | 2918·55 | 359·5 | 79·0 | 8·13 | 6·65 | 6 |
| 1/2 Jersey-Sindhi .. | 13 | 4765·14 | 382·3 | 59·5 | 12·46 | 10·78 | .. |
| 3/8 Jersey-Sindhi .. | 1 | 4126·2 | 458 | 133 | 9·0 | 6·9 | .. |
| 1/8 Holstein-Sindhi .. | 5 | 1758·54 | 269 | 121·7 | 6·5 | 4·5 | 1 |
| 1/4 Holstein-Sindhi .. | 2 | 801·1 | 120·5 | 123 | 6 6 | 3·2 | 1 |
| 3/16 Holstein-Sindhi .. | 1 | 1573·1 | 207 | 183 | 7·5 | 4·03 | .. |
| 3/8 Holstein-Sindhi .. | 1 | 5795·4 | 355 | 12 | 16·32 | 15·79 | .. |
| 1/8 Brown Swiss-Sindhi .. | 2 | 2403·25 | 262·5 | 68 | 9·2 | 7·2 | 1 |
| 1/4 Brown Swiss-Sindhi .. | 5 | 4562·12 | 417·4 | 167·75 | 10·92 | 7·79 | .. |
| 1/2 Brown Swiss-Sindhi .. | 2 | 5535 3 | 391 | 65 | 14·15 | 12·13 | .. |
| 1/4 Guernsey-Sindhi .. | 2 | 2582·6 | 389 5 | 148·5 | 6·6 | 4·8 | .. |
| Jersey .. | 1 | 2865·7 | 291 | 38 | 9·84 | 8·71 | .. |
| Miscellaneous .. | 4 | 4393·27 | 450·5 | 71·3 | 9·7 | 8·4 | 1 |
| Murrah-Buffalo .. | 15 | 3421·97 | 318 | 228·9 | 10·77 | 6·2 | 1 |

The cows are more economical milk producers than are our buffaloesd Figuring 8 pounds of milk to the rupee and using the actual cost of fodder an·h concentrates we calculated the value of milk produced and feed costs for eac., animal. Labour, water, electricity, interest on investment, depreciation, etcs were not considered. Our 145·8 cows had an overall daily average of 8·5 pound of milk giving 4,05,668·8 pounds worth Rs. 50,080-3-4. They ate Rs. 26,456-13-11 worth of feed leaving Rs. 23,623-5-5 over feed costs. On the other hand, 31·9 buffaloes yielded 62,576·8 lbs. of milk worth Rs. 7,646-1-6 and ate Rs. 7,641-10-1 worth of feed. We had only Rs. 4-7-5 left for other expenses so the buffaloes were a liability to us. Their overall average yield was 5·9 pounds. There are more buffaloes than cows each year that are dry for several months and they are larger and eat more.

Table IV shows the monthly performance of each group of cows and buffaloes.

TABLE IV—*Showing the monthly performance of all cows and buffaloe in the herd.*

| | April | May | June | July | August | Sept. | Oct. | Nov. | Dec. | Jan. | Feb. | March | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Red Sindhi .. | 8876·8 | 5638·3 | 4870·9 | 4210·8 | 3901·8 | 4713·4 | 5216·2 | 5510·7 | 6126.6 | 6559·5 | 6539·2 | 6617.8 | Total | 6878·2·0 |
| Cows in Milk .. | 27 | 24 | 20 | 17 | 17 | 19 | 21 | 19 | 20 | 23 | 24 | 22 | Monthly average No. of cows | 39·1 |
| ,, Dry .. | 15 | 17 | 21 | 23 | 1·4 | 22 | 20 | 18 | 15 | 14 | 13 | 15 | | |
| Over-all Daily Average | 7·1 | 4·5 | 4·0 | 3·5 | 3·2 | 3·2 | 4.2 | 5·1 | 5·8 | 5·9 | 5·9 | 6·0 | Over-all daily average | 4·9 |
| ½ Jersey Sindhi .. | 7148·1 | 5887·1 | 4855 7 | 4457·4 | 4030·1 | 4439·1 | 4710·1 | 4315·6 | 5406·1 | 6459·2 | 7337·8 | 8441·1 | Total | 6,7887·4 |
| Cows in Milk .. | 17 | 17 | 15 | 15 | 15 | 15 | 14 | 13 | 12 | 15 | 17 | 17 | Monthly average No. of cows | 17·0 |
| ,, Dry .. | Nil | Nil | 2 | 2 | 2 | 2 | 3 | 4 | 5 | 2 | Nil | Nil | | |
| Over-all daily average | 14·1 | 11·6 | 9·5 | 8·7 | 8·7 | 8·7 | 9 4 | 8·5 | 10·5 | 12·7 | 14·7 | 16·6 | Over-all daily average | 11·1 |
| ¼ Holstein Sindhi .. | 1308 5 | 1621·0 | 1627·3 | 1877·2 | 1638·3 | 1553·0 | 1620·0 | 1623·8 | 1583·4 | 1440·1 | 1100·0 | 1029·1 | Total | 17921·7 |
| Cows in Milk .. | 4 | 4 | 5 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 3 | 3 | Monthly average No. of cows | 5·4 |
| ,, Dry .. | 2 | 2 | 1 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | | |
| Over-all daily average | 7·8 | 8·5 | 9·1 | 10·1 | 9·1 | 8·6 | 9·0 | 10·8 | 10·6 | 9·6 | 9·1 | 8·6 | Over-all daily average | 9·2 |
| ¼ Jersey Sindhi .. | 6683·5 | 6812·9 | 5568·2 | 5514·0 | 6593 6 | 7947·3 | 8649·6 | 8520 9 | 8779·5 | 8457·4 | 10596·6 | 112 94·5 | Total | 95518·0 |
| Cows in Milk .. | 23 | 21 | 21 | 20 | 23 | 26 | 26 | 25 | 24 | 29 | 30 | 28 | Monthly average No of cows | 30·2 |
| ,, Dry .. | 6 | 7 | 5 | 6 | 6 | 4 | 5 | 6 | 7 | 6 | 4 | 5 | | |
| Over-all daily average | 7·7 | 8·1 | 7·3 | 7·7 | 7·6 | 8·8 | 9·3 | 9·2 | 9·4 | 8·5 | 10·4 | 11·4 | Over-all daily yield | 8·8 |
| ¼ Brown Swiss Sindhi, | 2966·0 | 3505·4 | 3619·0 | 3825·5 | 3524·1 | 3548.2 | 5699·5 | 4232·0 | 4101·1 | 3701·7 | 4106·3 | 3945·5 | Total | 46174·3 |
| Cows in Milk .. | 9 | 12 | 12 | 11 | 11 | 13 | 14 | 11 | 10 | 11 | 12 | 8 | Monthly average No. of cows | 15·1 |
| ,, Dry | 7 | 5 | 5 | 5 | 4 | 2 | 1 | 4 | 5 | 4 | 3 | 2 | | |
| Over-all daily average | 6·2 | 6·9 | 7·1 | 7·9 | 7·8 | 7·9 | 11·3 | 9.4 | 9·3 | 8·2 | 9·3 | 13·2 | Over-all daily average | 8·7 |
| ⅜ Jersey Sindhi .. | 563·7 | 404·9 | 372·2 | 397·9 | 578·1 | 486 4 | 438·8 | 1749·7 | 1781·0 | 1485·3 | 1573·1 | 1810·2 | Total | 11641·3 |
| Cows in Milk .. | 2 | 2 | 2 | 3 | 3 | 3 | 4 | 3 | 4 | 4 | 4 | 5 | Monthly average No. of cows | 3·5 |
| ,, Dry .. | 1 | 1 | 1 | Nil | Nil | 1 | Nil | Nil | Nil | Nil | Nil | Nil | | |
| Over-all daily average | 6·3 | · | 4·1 | 4·4 | 6·4 | 5·4 | 4·9 | 14 6 | 19·8 | 12·4 | 13·1 | 12·0 | Over-all daily average | 9·0 |
| ⅜ Holstein Sindhi .. | 2064·4 | 1206·7 | 1598·2 | 1448·4 | 1355·9 | 1043·0 | 996·5 | 719·8 | 672·3 | 1342·9 | 2620·6 | 2417·5 | Total | 17486·2 |
| Cows in Milk .. | 6 | 6 | 7 | 7 | 7 | 6 | 6 | 4 | 4 | 7 | 6 | 7 | Monthly average No. of cows | 6·0 |
| ,, Dry .. | 4 | 3 | 2 | 2 | 2 | 3 | 3 | 2 | 1 | 1 | 1 | 1 | | |
| Over-all daily average | 6·9 | 4·5 | 5·9 | 5·4 | 5·0 | 3·9 | 3·7 | 4·2 | 4·5 | 5·6 | 12·5 | 10·1 | | |
| Brown Swiss Sindhi .. | 321·0 | 273·1 | 491·8 | 492·9 | 338·2 | 701·5 | 1495·7 | 1507·3 | 1295·2 | 728·3 | 525·3 | 403·5 | Total | 8575·0 |
| Cows in Milk .. | 1 | 2 | 2 | 2 | 2 | 3 | 4 | 4 | 3 | 2 | 2 | 1 | Monthly average No. of cows | 2·9 |
| ,, Dry .. | 2 | Nil | Nil | Nil | 1 | 1 | Nil | Nil | Nil | 1 | 1 | 1 | | |
| Over-all daily average | 3·6 | 4·6 | 8·2 | 8·2 | 3·8 | 5·8 | 12·4 | 12·6 | 14·4 | 8·1 | 5·8 | 6·1 | Over-all daily average | 3·7 |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ½ Brown Swiss x Sindhi ½ Brown Swiss x Hariana | 2375·7 | 1862·6 | 1879·8 | 1862·9 | 1631·5 | 1367·7 | 1181·4 | 1067·4 | 1187·9 | 947·1 | 905·0 | 1212·3 | Total | 17481·3 |
| Cows in Milk .. | 5 | 5 | 5 | 5 | 4 | 5 | 3 | 3 | 3 | 3 | 3 | 3 | Monthly average | |
| " Dry .. | Nil | Nil | Nil | Nil | 1 | Nil | 2 | 2 | 2 | 2 | 2 | 2 | No. of cows | 5·0 |
| Over-all daily average | 15·8 | 12·4 | 12·5 | 12·4 | 10·9 | 9·1 | 7·9 | 7·9 | 7·9 | 6·5 | 6·1 | 8·1 | Over-all daily average | 9·7 |
| 3/8 Holstein Sindhi | 520·8 | 478·6 | 470·3 | 440·1 | 382·2 | 355·2 | 245·5 | Nil | 948·1 | 968·5 | 875·4 | 631·3 | Total | 6315·7 |
| Cows in Milk .. | 1 | 1 | 1 | 1 | 1 | 1 | 1 | Nil | 1 | 1 | 1 | 1 | Monthly average | |
| " Dry .. | Nil | Nil | Nil | Nil | Nil | Nil | Nil | 1 | Nil | Nil | Nil | Nil | No. of cows | 0·9 |
| Over-all daily average | 8·7 | 8·0 | 7·8 | 7·3 | 6·4 | 5·9 | 4·1 | Nil | 15·8 | 16 1 | 14·6 | 10·5 | Over-all daily average | 8.8 |
| Jersey .. | 288·7 | 227·4 | 204·6 | 131·2 | 100·6 | 218·9 | 350·1 | 413·1 | 508·1 | 457·3 | 353·1 | 374·1 | Total | 3627·2 |
| Cows in Milk .. | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | Monthly average | |
| " Dry .. | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | No. of cows | 2·1 |
| Over-all daily average | 3·2 | 3·8 | 3·4 | 2·2 | 1·7 | 3·6 | 5·8 | 6·9 | 8·5 | 7·6 | 5·9 | 6·1 | Over all daily average | 4·7 |
| Miscellaneous | 5663·2 | 4546·4 | 3725·0 | 3706 | 3530·6 | 3194·0 | 3296·3 | 2925·1 | 2851·9 | 3241·8 | 3131·5 | 4446·5 | Total | 44258·7 |
| Cows in Milk | 18 | 17 | 16 | 15 | 15 | 13 | 12 | 11 | 7 | 10 | 10 | 12 | Monthly average | |
| " Dry .. | Nil | Nil | 1 | 2 | 1 | 2 | 2 | 1 | 3 | 3 | 3 | Nil | No. of cows | 14·5 |
| Over-all daily average | 10·5 | 8 9 | 7·3 | 7.2 | 7·3 | 7·1 | 7·8 | 8·1 | 9·5 | 8·3 | 8·0 | 12·3 | Over-all daily average | 8·5 |
| Murrah Buffaloes .. | 4374·2 | 3444·7 | 4449·2 | 5·4 | 5047·6 | 5792·1 | 5851·1 | 7073·6 | 6645·7 | 5581·0 | 4727·8 | 4563·4 | Total | 62576·8 |
| Buffaloes in Milk .. | 18 | 16 | 14 | 15 | 15 | 19 | 20 | 18 | 15 | 16 | 16 | 14 | Monthly average | |
| " Dry .. | 21 | 24 | 26 | 24 | 24 | 18 | 14 | 9 | 7 | 6 | 6 | 8 | No. of buff | 31·9 |
| Over-all daily average | 3·8 | 2·9 | 3·7 | 4·3 | 4·3 | 5·2 | 5 7 | 8·7 | 10·1 | 8·5 | 7·1 | 6·5 | Overall daily average | 5·9 |
| Total Cows in Milk .. | 38780·4 | 32364·4 | 29382·9 | 28364·7 | 28005·0 | 29567·7 | 33299·7 | 32585·4 | 35241·2 | 35789·1 | 39663·9 | 32623·4 | Total | 40·5668·8 |
| Cows in Milk | 144 | 112 | 107 | 101 | 103 | 104 | 110 | 98 | 93 | 110 | 113 | 108 | Monthly average | |
| " Dry .. | 39 | 36 | 39 | 43 | 34 | 40 | 39 | 40 | 40 | 35 | 29 | 28 | No. of buffs | 145·8 |
| Over-all daily average | 7·1 | 7·5 | 6·7 | 6·6 | 6·8 | 6·6 | 7·5 | 7·9 | 8·8 | 8·2 | 9·3 | 8·0 | Over-all daily yield | 8·4 |

TABLE V

*The average age, weight and height at withers at first calving of* 48 *heifers transferred to milch stock during the year* 1944-45.

(*April* 1943—*March* 1944.)

| Breed. | Average Age in years. | Average wt. in lbs. | Average height at wither. | Number of animals. |
|---|---|---|---|---|
| Red Sindhi .. .. .. .. | 3·55 | 611·85 | 44·07 | 7 |
| 1/4 Jersey-Sindhi .. .. .. | 3·06 | 604·20 | 43·55 | 15 |
| 1/4 Brown Swiss-Sindhi .. .. | 3·30 | 600·00 | 44·60 | 1 |
| 1/8 Brown Swiss-Sindhi .. .. | 3·49 | 599·50 | 44·90 | 2 |
| 1/8 Jersey-Sindhi .. .. .. | 3·14 | 551·80 | 43·66 | 5 |
| 1/6 Jersey Sindhi .. .. .. | 2·40 | 505·00 | 42·50 | 1 |
| 1/8 Holstein-Sindhi .. .. .. | 3·00 | 525.00 | 43·22 | 4 |
| 3/16 Holstein-Sindhi .. .. .. | 3·13 | 483·00 | 42·30 | 1 |
| 1/4 Holstein-Sindhi .. .. .. | 3·64 | 665·00 | 45·70 | 1 |
| 1/8 Guernsey Sindhi .. .. .. | 3·63 | 566·00 | 42·30 | 2 |
| 1/4 Guernsey-Sindhi .. .. .. | 2·81 | 605·00 | 44·4 | 1 |
| Miscellaneous .. .. .. | 3·52 | 572·00 | 44·02 | 5 |
| Murrah Buffaloe .. .. .. | 4·0 | 1146·66 | 52·30 | 3 |

The ages at first calving are not as favourable as during recent years. The increase is undoubtedly due to the severe fodder shortage we experienced in the summers of 1942 and 1943 when these heifers were young.

TABLE VI

**Female Young Stock.**

| Sl. No. | Breed. | Total Strength on 1-4-44. | Born during the year. | Transferred to milch stock. | Died. | Total strength on 31-3-45. |
|---|---|---|---|---|---|---|
| 1 | Red Sindhi .. | 31 | 13 | 7 | 5 | 35 |
| 2 | 1/16 Jersey Sindhi .. | 4 | .. | 1 | .. | 3 |
| 3 | 1/8 Jersey-Sindhi .. | 25 | 4 | 5 | .. | 24 |
| 4 | 1/4 Jersey-Sindhi .. | 37 | 16 | 15 | 8 | 30 |
| 5 | Jersey × Sindhi .. | 2 | 6 | .. | 3 | 5 |
| 6 | 5/8 Jersey × Sindhi. | 1 | .. | .. | .. | 1 |
| 7 | Jersey .. .. | 1 | 1 | .. | .. | 2 |
| 8 | 1/16 Holstein × Sindhi | 7 | .. | .. | . | 7 |
| 9 | 1/8 Holstein × Sindhi | 10 | 4 | 4 | 2 | 8 |
| 10 | 3/16 Holstein × Sindhi | 1 | .. | .. | .. | 1 |
| 11 | 1/4 Holstein Sindhi | 1 | 1 | 1 | .. | 1 |
| 12 | 1/8 Bs × Sindhi .. | 20 | 2 | 2 | 2 | 22 |
| 13 | 1/4 Bs × Sindhi × 1/4 Brown-swiss × Hariana .. | 5 | 1 | 1 | 2 | 8 |
| 14 | Miscellaneous .. | 20 | 9 | 9 | .. | 13 |
| 15 | Murrah Buff. .. | 37 | 4 | 4 | 9 | 33 |
| 16 | 1/8 Guernsey × Sindhi .. | .. | .. | .. | .. | 1 |
| 17 | 1/4 Guernsey × Sindhi .. | .. | .. | .. | 1 | .. |
| | Total .. | 205 | 70 | 48 | 29 | 198 |

## Artificial Insemination.

This year 108 calves were secured from 114 direct services and 28 calves from 40 artificial inseminations. Artificial insemination was used for difficult breeders, any animal having some inflamation of the reproductive tract or when we had a number of animals in heat at the same time. Data on the results from natural and artificial breeding are given in Tables VII and VIII.

TABLE VII.

Calves born during the year as a result of Direct Service.

| Breed of Cow. | | No. of cows. | No. of services. | Calves Produced. | | Average birth wt. in lbs. | Average height in inches at withers. |
|---|---|---|---|---|---|---|---|
| | | | | Male. | Female. | | |
| Red Sindhi | .. | 23* | 24 | 11 | 12 | 41.4 | 24·1 |
| 1/4 Jersey-Sindhi | .. | 24 | 30 | 14 | 10 | 42.4 | 24·3 |
| 1/2 Jersey-Sindhi | .. | 11 | 14 | 9 | 2 | 48.7 | 26·1 |
| Jersey | .. | 1 | 1 | 0 | 1 | 25.0 | 21 3 |
| 1/8 Holstein-Sindhi | .. | 4 | 6 | 1 | 3 | 32.7 | 23·6 |
| 1/4 Holstein-Sindhi | .. | 1 | 3 | .. | 1 | 41.0 | 24 3 |
| 1/8 Brown Swiss-Sindhi | .. | 4 | 8 | 1 | 3 | 45 8 | 25·2 |
| 1/4 Brown Swiss Sindhi | .. | 9 | 10 | 4 | 5 | 46.3 | 25·1 |
| 1/4 Guernsey Sindhi | .. | 1 | 1 | .. | 1 | 45.0 | 25·2 |
| Miscellaneous | .. | 8 | 9 | 3 | 5 | 44.7 | 24·4 |
| 1/8 Jersey Sindhi | .. | 7 | 9 | 3 | 4 | 39 4 | 25·7 |
| 1/16 Jersey Sindhi | .. | 1 | 1 | 1 | .. | 39.0 | 24·2 |
| 1/8 Holstein Sindhi | .. | 1 | 1 | .. | 1 | 25.0 | 24·3 |
| Murrah Buffalo | .. | 13 | 17 | 6 | 7 | 68.1 | 26·1 |
| Total | .. | 108 | 114 | 53 | 55 | .. | .. |

*2 grade Sindhis Nos. 709 and 743 are included.

TABLE VIII.

*Calves produced during the year as a result of Artificial Insemination.*

| Breed of cow | | No. of cows. | No. of insemina-tions. | Calves Produced | | Average birth wt. in lbs. | Average height in inches at withers. |
|---|---|---|---|---|---|---|---|
| | | | | Male | Female | | |
| Red Sindhi | .. | 2 | 2 | 1 | 1 | 39·0 | 24·6 |
| 1/4 Jersey Sindhi | .. | 8 | 12 | 2 | 6 | 39 3 | 23·8 |
| 1/2 Jersey Sindhi | .. | 4 | 4 | .. | 4 | 45·5 | 25·2 |
| 1/8 Holstein Sindhi | .. | 2 | 3 | 1 | 1 | 44·4 | 25·2 |
| 1/4 Holstein Sindhi | .. | 1 | 1 | 1 | .. | Born- | Dead |
| 1/4 Brownswiss Sindhi | .. | 3 | 6 | 1 | 2 | 46·0 | 26 4 |
| 1/8 Guernsey Sindhi | .. | 1 | 1 | .. | 1 | 45·0 | 23·0 |
| Murrah Buffaloe | .. | 7 | 11 | 5 | 2 | 68·5 | 27·4 |
| Total | | 28 | 40 | 11 | 17 | .. | .. |

## SWINE

We increased our swine herd almost three fold and butchered 52 pigs during the year. The total live-weight of the swine butchered was 9597 lbs. Table IX gives the statistics on swine.

The large number of losses in young pigs was primarily due to poisoning of whole litters by carelessness on the part of the men caring for them. The same cloth used to apply a poisonous antiseptic was used to apply anti-anæmia medicine to the sow's udders. We searched in vain for an infectious disease before the cause of the trouble was located.

One adult male died from foot-and-mouth disease; one from cyanide poisoning and the female from posterior paralysis. No infections nor perisitic diseases have yet appeared in the herd other than an attack of foot-and-mouth which part of the herd contracted from the cattle in May and June.

TABLE IX.

*Swine Statistics for* 1944-45.

| | Sex. | Stock on 1-4-'44 | Born. | Purchased. | Return of Service. | Sold for breeding. | Died. | Butchered. | Transferred from young Stock. | Transferred to Adult Stock. | Stock in hand on 1-4-'45. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Adults | Male | 26 | .. | 1 | .. | 15 | 2 | 31 | 24 | .. | 3 |
| | Female | 55 | .. | 2 | .. | .. | 1 | 21 | 17 | .. | 52 |
| Weaned pigs. | Male | .. | .. | .. | .. | 7 | .. | .. | 118 | 24 | 87 |
| | Female | .. | .. | .. | .. | 1 | .. | .. | 91 | 17 | 73 |
| Un-weaned pigs. | Male | .. | 195 | .. | 2 | .. | 48 | .. | .. | 118 | 44 |
| | Female | .. | 151 | .. | 4 | .. | 41 | .. | .. | 91 | 32 |
| | Total . | 103 | 346 | 3 | 6 | 23 | 92 | 52 | 250 | 250 | 291 |

## SHEEP

We sold all coloured sheep in the flock. The Corriedale grade lambs grew faster than the original stock and showed considerable improvement in their fleeces, over those of their dams. We ended the year with a smaller but better flock than we had the year before.*

All lambs were docked at about one week old and were kept in a welded wire cage to keep the crows away from them until their tails had healed. In this way losses due to tetanus were eliminated. Statistics on the sheep are given in Table X.

TABLE X

*Sheep statistics for* 1944-45.

| Sex. | Stock on April 1st, 1944. | Born. | Sold. | Butchered. | Died | Stock in hand on 1-4-'45. |
|---|---|---|---|---|---|---|
| Male .. .. | 26 | 26 | 11 | 2 | 18 | 21 |
| Female .. .. | 92 | 11 | 13 | 2 | 27 | 61 |
| Total .. | 118 | 37 | 24 | 4 | 45 | 82 |

*Our sheep produce a very fine wool. We shear them twice a year. The best clip in April last year was 2·5 lbs. of wool from No. 357. We secured a little over 100 pounds from the flock each shearing.

## GOATS

Our goat herd did not increase appreciably even though a good number of kids were born. Losses were very heavy owing to internal parasites and out-breaks of hæmorrhagic septicæmia. Table VI gives the statistics on goats.

The total yield of 14 goats was 4,414·1 lbs. of milk for the year, No. 03 gave the best yield which was 681·3 pounds in 375 days, more than twice the average for the herd (315·3 lbs).

TABLE XI.

*Goats statistics for* 1944-45.

| Sex. | Stock on April 1st, 1944. | Born. | Died. | In hand on 1-4-'45. |
|---|---|---|---|---|
| Male .. .. | 7 | 19 | 18 | 8 |
| Female .. .. | 21 | 10 | 8 | 23 |
| Total .. | 28 | 29 | 26 | 31* |

*Out of these 31 there are 16 young *i.e.*, 6 males and 10 females.

## POULTRY

*Stock of Poultry on hand in the beginning of the year* 1944-45.

| | W. L. H. | | R. I. R. | | Silky. | | Ducks. | | Turkey. | | Geese. | | G. Fowl. | | Capons. | Chickens. | Ducklings. | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | F. | M. | F. | M. | F. | M. | F. | M. | F. | M. | F. | M. | F. | M. | | | | |
| On 1st April, 1944. | 100 | 27 | 22 | 5 | 23 | 2 | 5 | 2 | 2 | 1 | 2 | 1 | .. | .. | 9 | 75 | 37 | 313 |
| On 31st March, 1945 | 96 | 20 | 30 | 5 | 12 | 2 | 71 | 32 | 2 | 1 | 3 | 1 | 4 | 3 | 3 | 373 | 96 | 754 |

*Eggs* :—In all 8,588 eggs were produced during the year under review. Out of these 2,995 were sold to the public for hatching, 2,941 were sold for table, and 2,652 were used on the farm for setting in incubators.

*Sale of Fowls* :—In all 89 birds were sold for breeding and 120 for table purpose. There has been no epidemic during the year and the condition of the fowls is fairly good.

*Ducks* :—White Indian Runner ducks seem to be getting very popular and they have given good results in regard to egg production. We intend keeping a large flock of Indian Runner Ducks during the next year.

## BLOOD MEAL

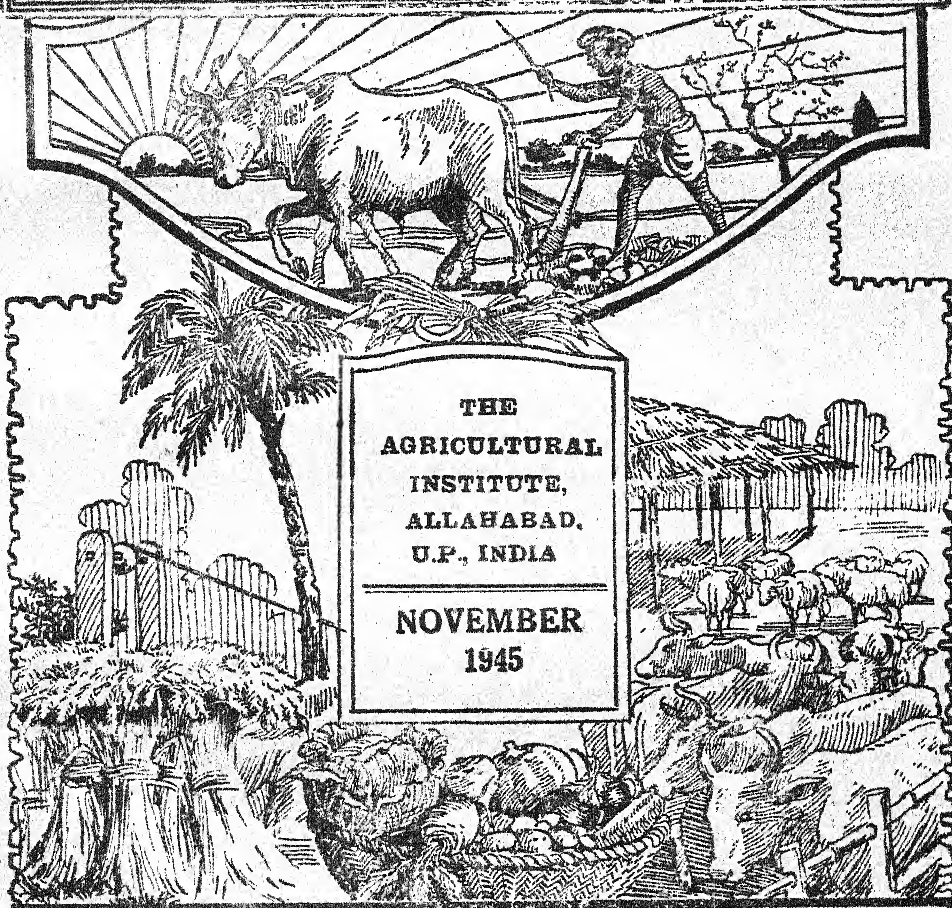
We increased our production of blood meal to 23,636·3 pounds. This was fed to the swine and poultry as their source of animal protein and to the young calves in place of part of the usual milk allowance.

*Published by* :—The Allahabad Agricultural Institute, Allahabad. U.P. (India)

VOL. XIX] [No. 6

# THE ALLAHABAD FARMER

A bi-monthly Journal
OF
Agriculture and Rural Life



THE
AGRICULTURAL
INSTITUTE,
ALLAHABAD,
U.P., INDIA

NOVEMBER
1945

" The application of engineering knowledge to agriculture can be best done by those trained in both engineering and agriculture, that is by agricultural engineers."

M. VAUGH.

YOUR CO-OPERATION

IS

SOLICITED

---

FILL IN THIS FORM

NOW!

I think those below, if not already on your books, may be interested in "THE ALLAHABAD FARMER."

*Signed*..............................................................................

*Address*............................................................................

..............................................................................

Name..............................................................................

Address..............................................................................

..............................................................................

Name..............................................................................

Address..............................................................................

..............................................................................

Name..............................................................................

Address..............................................................................

..............................................................................

Name..............................................................................

Address..............................................................................

..............................................................................

Name..............................................................................

Address..............................................................................

..............................................................................

Pease address envelope to :

The Editor,

THE ALLAHABAD FARMER,

Agricultural Institute,

ALLAHABAD, U. P.

# THE ALLAHABAD FARMER

## A BI-MONTHLY JOURNAL OF AGRICULTURE AND RURAL LIFE



The ALLAHABAD FARMER is now approved by the Directors of Public Instruction in the United Provinces, Bengal, Central Provinces, Sind, Assam, Bihar and Orissa, the Rural Reconstruction Commissioner, Punjab, and by the Director of the Institute of Plant Industry, Indore, and Agricultural Adviser to Rajputana and Central India States, for use in all schools under their jurisdiction.

### Subscription Rates

Annual subscription: India, Rs. 3; England, 4 shillings; U.S.A., 1 dollar. Single copies 10 annas; over five years old, 12 annas. Copies which are not received by subscribers will be supplied free of cost within six months of the month of issue. Thereafter single copy prices will be charged.

Unused portions of subscriptions cannot be refunded.

### Advertising Rates

| | Rs. | a. | p. |
|---|---|---|---|
| One full page of six numbers | 35 | 0 | 0 |
| One single full page | 7 | 0 | 0 |
| One half page of six numbers | 20 | 0 | 0 |
| One single half page | 4 | 0 | 0 |
| Page 2 or 3 of cover for six numbers | 50 | 0 | 0 |
| Page 4 of cover for six numbers | 70 | 0 | 0 |

### Contributions

The ALLAHABAD FARMER is published in the first week of each alternate month commencing with the month of January. Contributors are requested to send in their articles at least one month prior to the next prospective date of publication.

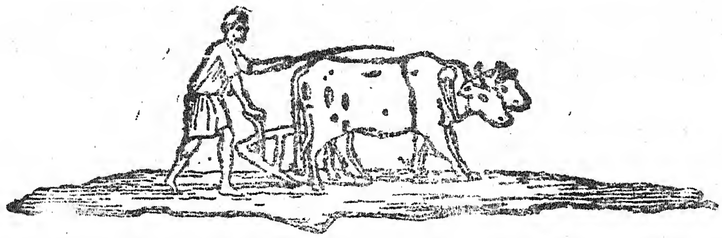
Contributors will receive 15 reprints of the article published and additional copies at cost.


*Publisher*—The Allahabad Agricultural Institute, Allahabad, U.P. (American Presbyterian Mission).

*Printer*—The Mission Press, Allahabad, U.P.


## CONTENTS

# THE
# ALLAHABAD FARMER



VOL. XIX] NOVEMBER, 1945 No. 6 ]


## Editorial

**Agricultural Engineering in Post-War India.**

Engineering is, as yet, very limited in scope in this country. While most countries of the world have made use of this science for their every day living, in India engineering is very much confined to large industrial works, and that, also, in a very limited way. This is reflected even by the way in which the subject of engineering is taught in most universities or engineering institutions in this country. The subject is still being split up into civil, mechanical and electrical engineering. In more advanced countries of the West the science of engineering is studied more particularly from the point of view of application. Thus they have mining engineering, automotive engineering, chemical engineering, agricultural engineering, etc. It is agricultral engineering, or the application of engineering to agriculture, that we wish particularly to discuss briefly in this editorial.

To a country such as India, where certain phases of engineering are still in a very backward state, one may wonder as to what sort of engineering there could be in agriculture. But in countries where engineering is freely applied in agricultural practices, this question does not even arise. Engineering in agriculture in India at the present time is confined almost completely to irrigational structures and, to a very little extent, to farm implements and machinery. But, in the more highly advanced countries of the West, agricultural engineering also includes the study of farm "power," that is the farm tractor, steam, wind and water power; farm structures; rural electrification; and soil and water control. Thus, the application of engineering to the development of power for use in farming; the production of suitable farm machinery and implements; the construction of suitable farm buildings, such as the cultivator's home, barns for animals, poultry shelters, granaries and even fences; electrification of rural homes; extending the use of electricity for water supply, threshing and cutting of fodder; the use of electricity in electric-heated brooders for young pigs and poultry, in electric blowers for curing of grain and hay, and in electric fences; etc., etc.; all call for expert knowledge which rural India of the immediate future very urgently needs. The scope of agricultural engineering in the U. S. A. may be indicated by the subjects which a student going in for such training is required to take up. These are Chemistry, Algebra, Trigonometry, Mechanical drawing, Foundry production, Analytical mathematics, Descriptive geometry, Heat treating and welding, Physics, Calcu-

lus, Surveying, Metallurgy, Machine design or Mechanisms, Statics, Thermodynamics, Strength of materials, Farm Motors, Farm structures, Hydraulics, Road engineering, Electrical engineering, Farm crops, Farm management, Soil science, Soil and water conservation, Geology, and Farm and dairy machinery.

India today, however, possesses very few agricultural engineers. In fact, some of them have become agricultural engineers without previous training in agricultural engineering. This has been one reason for serious criticisms of the activities or lack of activities of the engineering sections of the agricultural departments in this country. In fact, the attitude of those who were responsible for certain phases of agricultural engineering to agricultural implements, was entirely wrong. Improvement in agricultural implements in this country meant, in those early days, the introduction of English implements; and efforts were made to adapt them to Indian agriculture. The outlook has changed, and work on the evolution of agricultural implements suitable for India has already been started by agricultural departments and agricultural institutions in various parts of the country. Those who are responsible for the development of these implements have also realized the need of making themselves fully conversant with the problems which confront the cultivator. But these efforts are entirely inadequate to meet the need of this country. Agricultural engineers are needed not only by the scores or hundreds but by thousands, if agricultural engineering is to make its possible contribution to the progress of the country. The training of agricultural engineers is, therefore, an immediate need.

The Central Government and various provincial governments are beginning to be aware of this need, and have sent out students to the U. S. A. and Canada to qualify themselves as agricultural engineers by getting their training in institutions of those countries. While we heartily approve of the projects, yet we feel constrained to make the following observations: (1) that only young men who are familiar with agricultural problems of this country should be sent for such studies in foreign countries, (2) that for some years to come, those men in many cases, will not be in a position to dictate policies regarding agricultural engineering developments in this country, and (3) that immediate steps be taken to expand agricultural institutions in this country so that they can provide the right kind of engineering training for future agricultural engineers of this country. Such training should, at present, include the construction of masonry wells and tube wells, tillage implements, harvesting implements and machinery, sugar machinery, dairy machinery, water lifts, country carts, engines, tractors, etc. Such training given in this country would more quickly and efficiently solve the engineering problems of this country than training given somewhere else outside India.

There are few countries in the world which because of their natural topographies are as suitable for a large scale use of agricultural machinery as is this country. The Indo-Gangetic plain, because of its wide expanse, is probably more suitable than any other region of the world, of a similar size, for large scale farming. But this natural advantage of the country could not be made use of because of the smallness of fields in this country. When the average size of a cultivator's holding in this country is 5-6 acres, and when this holding is in scattered areas in various parts of the village land, we can understand how small the size of the cultivator's fields are, which makes them unsuitable for any large scale use of farm machinery. We hope steps will be taken in order to make it possible for the country to make full use of the natural advantage which it possesses, in order that this nation can march with the rest of the world in its way to agricultural and industrial progress, and thereby make its appearance once again on the world stage.

The Allahabad Agricultural Institute by instituting a degree course in Agricultural Engineering is making efforts to contribute to the natural development which is going to take place in the near future. But this effort is much too small and sadly inadequate to meet the need of agricultural engineering of rural India. It is only a fleabite when we think of the need of the country as a whole. We hope, therefore, that not only this institution but all other agricultural institutions in the country will make every effort to help extend this much needed agricultural development.

## THE VIJAYA WHEAT.

By

B. M. Pugh,

*Head of the Department of Agronomy, Allahabad Agricultural Institute.*

### INTRODUCTORY.

Dr. Shri Ranjan, Head of the Botany Department of the Allahabad University, by treating the grains of Imperial Pusa 52 wheat with X-ray, was able to evolve several varieties of wheat which showed a great deal of variation not only in their morphological characters but also in their physiological characteristics. These wheats were, therefore, very variable in their capacity to produce grain, that is, in their grain yields. Experiments conducted in Cawnpore with these wheats seem to show the superiority of some of these irradiated wheats, although the report also indicates that the wheats were insufficiently tested; among them was a variety known as X-9. This variety was, in fact, considered the best of the series of these irradiated wheats produced in the botanical laboratory of the Allahabad University. Dr. Shri Ranjan, in order to popularize this wheat, and also to do honour to one of the distinguished citizens of this country, who also happens to be the resident of Allahabad, gave the name of Vijaya to this X-9 wheat after the name of Mrs. Vijaya Lakshmi Pandit. In fact, the name was given to this wheat in an imposing ceremony in which Mrs. Pandit did the christening of the wheat, a function which was later reported in the daily papers. The reports drew the attention of some agricultural scientist in this province who claimed that the wheat is not really superior to the standard wheats of this province.

The agricultural experimentalist now has at his disposal a technique of experimentation which is able to show significant differences, if any, between any two varieties of a crop or between any two treatments. We refer to the modern statistical methods of field experimention which were developed by R. A. Fisher at the Rothamsted Experiment Station in England, and which have now been used throughout India; in fact, throughout the world However, because of the great variation of climate from one year to another, the results of one year's experiment tested even by this method are not considered conclusive. The statistician, therefore, usually carries on his varietal tests for three years or so before he can confidently adjudge any variety as superior. However, because of the interest that the public may have in the facts regarding the Vijaya wheat, we give below a report of the experiments carried on with this wheat and with the other irradiated wheats evolved in the Botanical laboratory of the Allahabad University.

Our attention to these wheats was drawn about two years ago. In order to test their inherent qualities we asked Dr. Ranjan if he would give us some seeds of each variety. The Agronomy department of the Allahabad Agricultural Institute had been conducting a series of varietal tests with wheats recommended by Government. Reports of these experiments have appeared from time to time in a magazine, the Allahabad Farmer (see Vol. XVI, pp. 105-120, Vol. XVI, pp.

315-316). Dr. Ranjan kindly supplied us some seeds of these irradiated wheats, but not sufficient enough for a full scale randomized block experiment. We, therefore, were able to grow these seeds on a small scale where we could make some observation on them and from which enough seed would be available the next crop season. We, therefore, report in full only the results of the experiments conducted in the crop season of 1944-45.

## THE PLAN OF THE EXPERIMENT.

At the Allahabad Agricultural Institute, we have at least three conditions in which these wheats could be tested : one under sewage irrigation ; another under tube-well irrigation ; and another without irrigation. But we were able this year to test these wheats only under the first two conditions, the first being the conditions of fairly good fertility, and the second being under poorer conditions. The latter is more representative of the conditions under which wheat is mostly grown in this province. But seeds for all the varieties tested were not quite sufficient, so that in the two experiments, one was not exactly a duplicate of the other.

**The experiment under sewage irrigation.**—In this experiment eight irradiated wheats and three standard wheats of this province were included. These were X-8, X-10, X-7, X-9, X-5, X-2, X-11, X-1, I.P. 52, I.P. 4, and Cawnpore 13. The layout of the experiment was as shown in diagram 1. The size of the layout was 179′×262′; the number of replications (that is the number of blocks in the layout) was 6, the size of the block was 88′ × 86′; and the number of rows in the plot was 8. Of these eight only six were taken for the experiment. That is, two rows on each side of the plot were left out from the experiment in order to do away with border effects. For the same reasons two feet on each end of the plots or of the rows were removed at the time of harvesting, so that the actual plot size used in the experiment is only 6′×82′ and the total size of the 6 plots for each variety is, therefore, only 6×6′×82′.

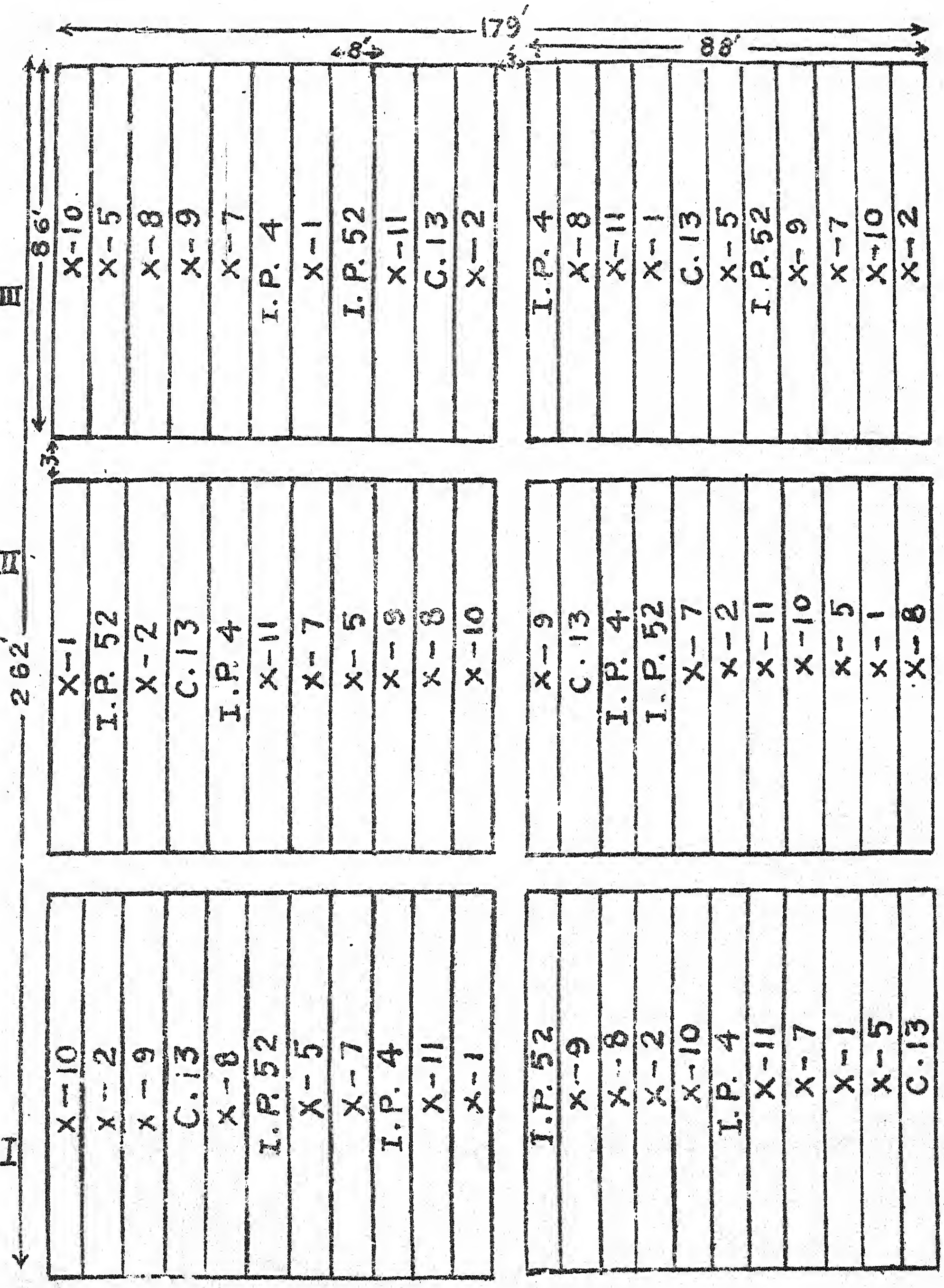



Diagram 1. Layout of the wheat varietal experiment, under sewage irrigation, showing the plan of the layout and randomization.

The first recorded observations made on this experiment was one on germination. An estimate was made on each of the experimental rows as to whether the germination was excellent, very good, good, fair, bad or very bad, and grades corresponding to these, namely, 6, 5, 4, 3, 2, 1, respectively, were given to the rows, and the total for each plot that is for 6 rows, was recorded. The data thus recorded are shown in table 1.

| Varieties I | BLOCKS I | II | III | IV | V | VI | Total |
|---|---|---|---|---|---|---|---|
| X-8 | 12 | 12 | 14 | 15 | 10 | 12 | 75 |
| X-10 | 21 | 17 | 21 | 18 | 16 | 17 | 110 |
| X-7 | 19 | 15 | 15 | 14 | 16 | 17 | 96 |
| I.P.52 | 24 | 22 | 20 | 25 | 19 | 20 | 130 |
| I.P.4 | 24 | 17 | 19 | 12 | 18 | 20 | 110 |
| X-9 | 21 | 20 | 20 | 20 | 14 | 17 | 112 |
| X-5 | 19 | 21 | 17 | 22 | 16 | 14 | 109 |
| C-13 | 15 | 19 | 20 | 17 | 15 | 16 | 102 |
| X-2 | 23 | 23 | 17 | 17 | 15 | 21 | 116 |
| X-11 | 20 | 17 | 21 | 18 | 15 | 19 | 110 |
| X-1 | 24 | 24 | 18 | 14 | 20 | 16 | 116 |
| Total | 222 | 207 | 202 | 192 | 174 | 189 | 1186 |

*Table* 1.—Showing the total grade obtained in each plot in respect of germination by each variety in the experiment.

Analyzing these data statistically we found a five per cent difference in the varieties with a 5.66 per cent standard error and a significant difference value equal to 17 based on the 5 per cent level of significance. The conclusion arrived at from the germination data is, therefore, as follows:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| I. P. 52 | [X-1 & X 2] | X-9 | [I. P. 4, X-10 & X-11] | X-5 | C. 13 | X-7 | X-8 |
| 130 | 116 | 112 | 110 | 109 | 102 | 96 | 75 |

That is, observations recorded on germination show a significant superiority of I. P. 52 to all the other wheats except X-1 and X-2. On the other hand, X-1 and X-2 are not significantly superior to the other wheats except X 7 and X-8; whereas X-9, I. P. 4, X-10, X-11, X-5, C. 13 and X-7 are significantly superior in germination only to X-8.

The next observation made on these wheats in this experiment was on their resistance to rust, a fungus disease which attacks leaves, stems and even the husk of the grain. However, no attempt was made at this time to record the resistance to the different kinds of rust, of which there are usually three, which attack the wheat crop. These three wheat rusts do not begin to attack the crop at the same time, so that the record we have and which is given in table 2 below represents the sum total of the effect of the resistance of the wheats at the particular time that the observation was made. The data were based on the estimate of the average resistance of the variety in the whole plot. The grades for the plots were again based on the same method as explained above for the germination, except that in this case a plot is taken as the smallest unit instead of a row in each plot. That is where a plot showed a fair resistance to rust, a grade of 3 was given to the variety which occupied the plot, where the resistance was very good, a grade of 5 was recorded for the plot and, therefore, for the variety, and so on.

| Varieties | BLOCKS | | | | | | Total |
|---|---|---|---|---|---|---|---|
| | I | II | III | IV | V | VI | |
| X-8 | 1 | 1 | 1 | 1 | 1 | 1 | 6 |
| X-10 | 3 | 3 | 2 | 4 | 4 | 3 | 19 |
| X 7 | 4 | 3 | 3 | 4 | 4 | 4 | 22 |
| I.P 52 | 4 | 3 | 4 | 4 | 4 | 4 | 23 |
| I.P.4 | 3 | 3 | 3 | 2 | 3 | 3 | 17 |
| X-9 | 5 | 4 | 4 | 5 | 5 | 4 | 27 |
| X-5 | 2 | 3 | 1 | 4 | 4 | 3 | 17 |
| C-13 | 3 | 4 | 3 | 4 | 4 | 4 | 23 |
| X-2 | 1 | 2 | 1 | 2 | 3 | 1 | 10 |
| X-11 | 4 | 2 | 4 | 4 | 4 | 4 | 22 |
| X-1 | 3 | 3 | 2 | 4 | 3 | 3 | 18 |
| Total | 33 | 31 | 28 | 38 | 39 | 34 | 203 |

*Table* 2.—Showing the estimate of the rust resistance of the varieties in the experiment.

These data when analyzed showed a very high significant difference among the varieties, and resulted in a standard error 5.5 per cent and a significant difference 2.88. The conclusion, therefore, arrived at from the rust data is as follows :—

X-9 I. P. 52 & C. 13 X-7 & X-11 X-10 X-1 X-5 & I. P. 4 X-2 X-8
27 23 22 19 18 17 10 6

That is, the observations made on rust resistance in this experiment show a significant superiority of X-9 to all the other wheats, whereas I. P. 52, C. 13, X-7 and X-11 are in the second group in the order of merit ; X-10, X-1, X-5, I. P. 4 are in the third group ; X-2 is in the fourth group by itself and X-8 is the last.

The next observation we wish to report here is on the yield of grain. The record of the yields of the various plots is as shown in table 3, and is given in

| Varieties. | BLOCKS | | | | | | Total |
|---|---|---|---|---|---|---|---|
| | I | II | III | IV | V | VI | |
| X 8 | 2.0 | 2 5 | 2 5 | 3.5 | 2 5 | 2.0 | 15.0 |
| X-10 | 12.5 | 11.0 | 11.5 | 10.0 | 9.5 | 8.5 | 63.0 |
| X-7 | 9.0 | 8.5 | 6.0 | 10.5 | 8.0 | 7.0 | 49.0 |
| I.P. 52 | 11.5 | 8.5 | 11.0 | 14.0 | 9.0 | 12.0 | 66.0 |
| I.P. 4 | 10.0 | 8.5 | 9.0 | 9.0 | 9.5 | 7.0 | 53.0 |
| X-9 | 10.5 | 10.5 | 10.5 | 11 5 | 9.0 | 11.5 | 63 5 |
| X-5 | 6.5 | 7.5 | 4.5 | 6 0 | 5.5 | 8.5 | 38 5 |
| C. 13 | 7 5 | 7 0 | 12.0 | 8.5 | 10.0 | 9.0 | 54.0 |
| X-2 | 2.5 | 4.0 | 4.0 | 4.5 | 6.0 | 4.0 | 25.0 |
| X-11 | 4.0 | 6.5 | 6.0 | 6.5 | 5.0 | 3.5 | 31.5 |
| X-1 | 12.0 | 15.0 | 10.5 | 10.5 | 11.5 | 6.5 | 66.0 |
| Total | 88.0 | 89.5 | 87.5 | 94.5 | 85.5 | 79.5 | 524.5 |

*Table* 3.—Showing the yield of grain (in seers) of aech variety, recorded per plot.

seers. On analyzing these data, we obtain a very very high significant difference among the varieties, with a standard error=8.05 per cent, and a significant difference=10.82. The conclusion, therefore, arrived at from the data on the yields of grain is as follows :—

| X-1 & I. P. 52 | X-9 | X-10 | C. 13. | I. P. 4 | X-7 | X-5 | X-11 | X-2 | X-8 |
|---|---|---|---|---|---|---|---|---|---|
| 66 | 63.5 | 63 | 54 | 53 | 49 | 38.5 | 31.5 | 25 | 15 |

These results show that X-1, I. P. 52, X-9, X-10 are in the first group in the order of merit and that there is no significant difference among them in grain yields. X-1 and I. P. 52 are significantly superior to C.13 and I. P. 4 while the latter are not significantly inferior to X-9 and X-10. And while C.13 and I. P. 4 are in the second group in which they are bracketed with X-9 and X-10, yet they are not significantly superior to X-7 ; and so on.

The next observation recorded was that on the yields, in seers, of straw (bhusa) in the various plots. The data are as shown in table 4.

| Varieties | BLOCKS | | | | | | Total |
|---|---|---|---|---|---|---|---|
| | I | II | III | IV | V | VI | |
| X 8 | 14.0 | 21.5 | 20.0 | 22.5 | 15.5 | 14.5 | 108.0 |
| X-10 | 23.5 | 29.0 | 18.5 | 35.0 | 25.5 | 26.5 | 158.0 |
| X-7 | 31.0 | 28.5 | 34.0 | 29.5 | 22.0 | 23.0 | 168.0 |
| I.P. 52 | 30.5 | 31.5 | 32.0 | 21.0 | 32.5 | 34.0 | 181.5 |
| I.P. 4 | 26.5 | 26.5 | 31.0 | 30.0 | 28.5 | 25.0 | 167.5 |
| X-9 | 24.5 | 29.5 | 31.5 | 29.5 | 29.5 | 13.5 | 158.0 |
| X-5 | 33.5 | 27.5 | 34.5 | 29.5 | 29.0 | 29.5 | 183.5 |
| C. 13 | 31.5 | 31.0 | 39.0 | 32.0 | 30.0 | 25.5 | 189.0 |
| X-2 | 26.5 | 24.0 | 31.0 | 29.5 | 26.0 | 23.0 | 160.0 |
| X-11 | 36.5 | 31.5 | 30.5 | 31.5 | 30.0 | 34.0 | 194.0 |
| X 1 | 28.0 | 40.0 | 31.5 | 30.5 | 25.5 | 25.5 | 180.0 |
| Total | 306.0 | 320.5 | 333.5 | 318.5 | 295.0 | 274.0 | 1847.5 |

*Table* 4,—Showing the yield (in seers), of straw of each variety, recorded per plot.

On analyzing the data, we obtain a very high significant difference among the varieties, with a standard error = 5·23 per cent and a significant difference = 24·64. The conclusion arrived at with respect to the yields of straw of the various varieties is as follows :—

| X 11 | C.13 | X-5 | I.P.52 | X-1 | X-7 | I.P.4 | X-2 | X-9 & X-10 | X-8 |
|---|---|---|---|---|---|---|---|---|---|
| 194 | 189 | 183.5 | 181.5 | 180 | 168 | 167.5 | 160 | 158 | 108 |

These results show that of the irradiated wheats, X-11, X-5 and X-1 are as rich in straw as the standard Government wheats C.13 and I. P. 52, X-9 (the Vijaya wheat) while not significantly inferior to I. P. 4 or I. P. 52 is significantly inferior to C.13 in the straw yield.

**The experiment in the tube well area.**—In this experiment only six of the irradiated wheats were tested, X-1, X-9, X-10, X-7, X-5, and X-11 ; two standard Government wheats, I.P. 52, and I.P. 165 ; and one local wheat F. F. 1 which had obtained a prize in a local fair—the Farmers' Fair. The layout of the experiment was as shown in diagram 2. The size of the layout was 147'×225', the number of replications was 6, the size of the block was 72'×73', the size of the plot was 8'×73', and the number of rows in the plot was 8. Of these eight, as in the previous experiment, only six were experimental ; and also two feet at each end of the plot was removed at the time of the harvesting in order to remove border effects, so that the unit experimental plot size is 6'×69', and the total size of the six plots under each variety is 6×6' × 69'.

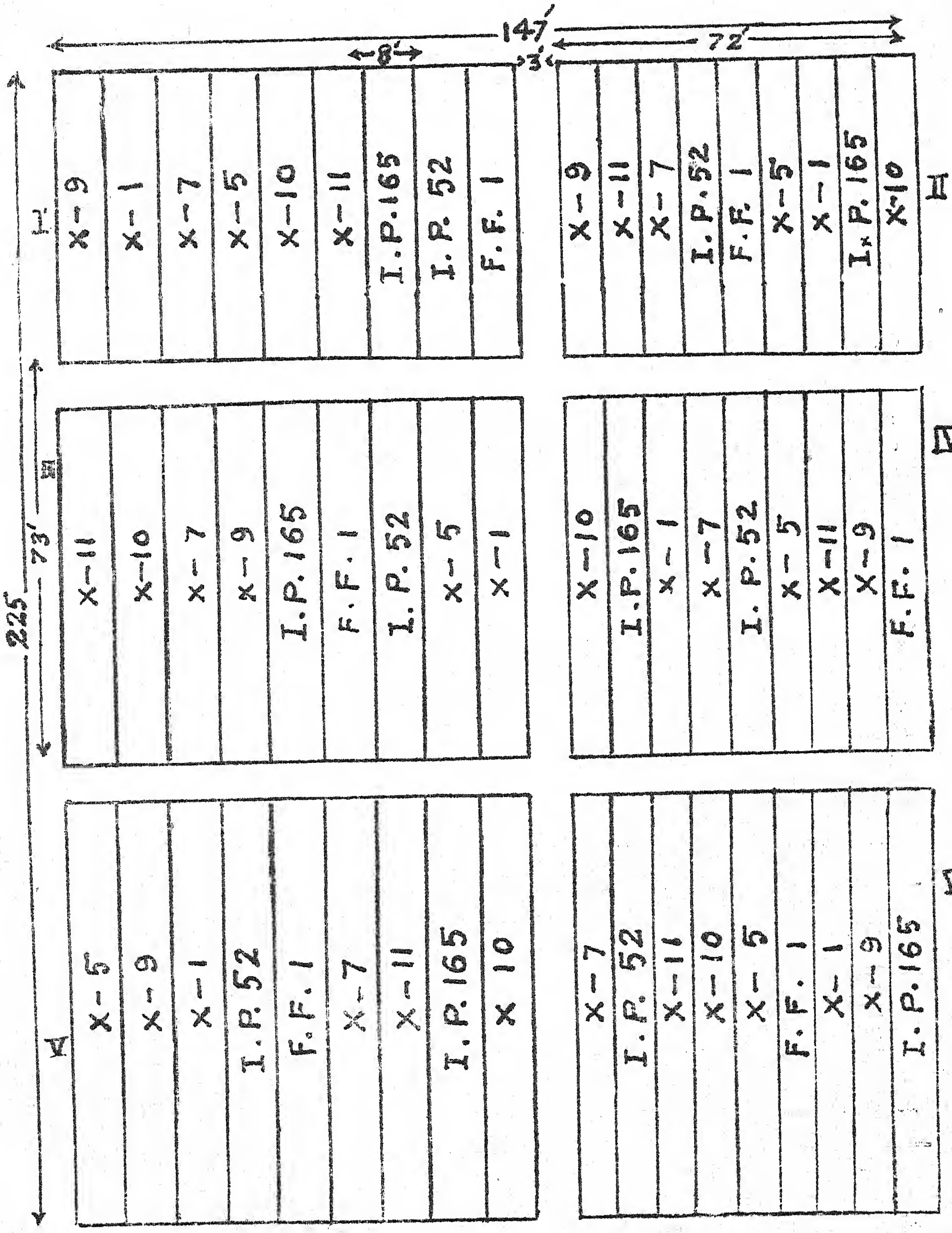



Diagram 2. Layout of the wheat varietal experiment, under tube-well irrigation, showing the plan of the layout and randomization.

The observations made on germination in this experiment were recorded as shown in table 5 :—

| Varieties. | BLOCKS | | | | | | Total. |
|---|---|---|---|---|---|---|---|
| | I | II | III | IV | V | VI | |
| I. P. 52 | 27 | 29 | 27 | 30 | 25 | 24 | 162 |
| X-1 | 24 | 33 | 28 | 27 | 26 | 27 | 165 |
| X-9 | 20 | 29 | 22 | 34 | 29 | 32 | 146 |
| X-10 | 22 | 30 | 22 | 24 | 26 | 19 | 143 |
| X-7 | 22 | 28 | 21 | 22 | 14 | 25 | 132 |
| X-5 | 23 | 29 | 28 | 27 | 21 | 24 | 152 |
| X-11 | 20 | 30 | 20 | 34 | 24 | 24 | 152 |
| F. F. 1 | 27 | 28 | 19 | 30 | 19 | 25 | 168 |
| I. P. 165 | 29 | 29 | 20 | 26 | 19 | 22 | 145 |
| To tal .. | 214 | 265 | 207 | 254 | 203 | 222 | 1365 |

*Table* 5.—Showing the total grade, obtained in each plot, in respect of germination, by each variety in the experiment.

The statistical analysis of these data shows a 5 per cent significant difference among the varieties, and yields a 5.34 per cent standard error and a significant difference=22.84. The conclusion, therefore, arrived at from these data is as follows :—

| F. F. 1 | X-1 | I. P. 52 | X-11 and X-5 | X-9 | I. P. 165 | X-10 | X-7 |
|---|---|---|---|---|---|---|---|
| 168 | 165 | 162 | 152 | 146 | 145 | 143 | 132 |

The results obtained in this experiment with germination agree fairly well with those obtained in the sewage area.

As in the other experiment, observation was made on the resistance of the wheats to rust. The observation was made on March 6, and the data recorded are shown in table 6. These data when analysed showed a high significance among the varieties, and yielded a standard error of 6.71 per cent and a

| Varieties. | BLOCKS | | | | | | Total. |
|---|---|---|---|---|---|---|---|
| | I | II | III | IV | V | VI | |
| I. P. 52 | 4 | 4 | 5 | 4 | 5 | 5 | 27 |
| X-1 | 5 | 4 | 4 | 5 | 4 | 3 | 25 |
| X-9 | 5 | 4 | 4 | 3 | 5 | 2 | 23 |
| X-10 | 3 | 3 | 3 | 3 | 3 | 3 | 18 |
| X-7 | 5 | 4 | 5 | 4 | 5 | 3 | 26 |
| X-8 | 2 | 1 | 2 | 2 | 1 | 1 | 9 |
| X-11 | 3 | 3 | 4 | 3 | 4 | 4 | 21 |
| F. F. 1 | 5 | 4 | 4 | 5 | 4 | 4 | 26 |
| I. P. 165 | 3 | 3 | 3 | 5 | 3 | 4 | 21 |
| Total | 35 | 30 | 34 | 34 | 34 | 29 | 196 |

*Table* 6.—Showing the estimates of the rust resistance of the varieties in the experiment.

significant difference=4.74. The conclusion, therefore, arrived at from these data is as follows :—

| I. P. 52 | X-7 and F. F. 1 | X-1 | X-9 | X-11 and I. P. 165 | X-10 | X-5 |
|---|---|---|---|---|---|---|
| 27 | 26 | 25 | 23 | 21 | 18 | 9 |

These results on germination obtained in this experiment under tube-well irrigation do not seem to agree closely with those obtained on germination in the other experiment under sewage irrigation. The reasons for these discrepancies will be discussed later.

The yield of grain on harvesting from the various plots was next recorded. These data are shown in table 7. The data when analyzed showed a 5 per cent

| Varieties. | BLOCKS | | | | | | Total. |
|---|---|---|---|---|---|---|---|
| | I | II | III | IV | V | VI | |
| I P.52 | 5·0 | 5.5 | 6.5 | 8.5 | 4.0 | 4.0 | 33.5 |
| X-1 | 7 5 | 7.0 | 5.5 | 4.0 | 5 0 | 8.0 | 37.0 |
| X-9 | 4.0 | 6 5 | 4.0 | 9.5 | 9.0 | 9.0 | 42.0 |
| X-10 | 4.5 | 5 5 | 7.0 | 4.5 | 4.5 | 5.0 | 31.0 |
| X-7 | 3 5 | 5.0 | 4.5 | 11.0 | 2.5 | 8.5 | 35.0 |
| X-5 | 3.0 | 4.0 | 3.5 | 4.0 | 5.5 | 4.0 | 24.0 |
| X-11 | 3.5 | 5.0 | 5.0 | 5.5 | 2.5 | 2.5 | 24.0 |
| F. F. 1 | 5.0 | 6.0 | 4.5 | 4.5 | 3.0 | 4.5 | 27.5 |
| I. P. 165 | 4.0 | 5.0 | 3.5 | 5 5 | 3.0 | 8.0 | 29.0 |
| Total | 40 0 | 49.5 | 44.0 | 57.0 | 39.0 | 53.5 | 238.0 |

*Table* 7.—The yield of grain (in seers), of each variety, recorded per plot.

significant difference among the varieties with a standard error of 16.07 per cent and a significant difference of 12.16. The conclusion therefore arrived at from these data is as follows :—

| X-9 | X-1 | X-7 | I. P. 52 | X-10 | I. P. 165 | F. F. 1 | X-5 and X-11 |
|---|---|---|---|---|---|---|---|
| 42 | 37 | 35 | 33.5 | 31 | 29 | 27.5 | 24 |

These results have not shown any significant difference between X-9 and I. P. 52, but X-9 is significantly superior to I P. 165, and is also superior to the local wheat F. F. 1.

Another set of data recorded in this experiment is on the yield of straw. The data are as shown in table 8. The analysis of the data showed a 5 per

| Varieties. | BLOCKS | | | | | | Total. |
|---|---|---|---|---|---|---|---|
| | I | II | III | IV | V | VI | |
| I, P·52 | 12.5 | 16.5 | 14.5 | 16.5 | 11.5 | .5 | 84.0 |
| X-1 | 15.5 | 24 0 | 14.5 | 20,0 | 17.0 | 20 5 | 111.5 |
| X·9 | 17.0 | 19.5 | 9 5 | 24.5 | 25.0 | 22.0 | 117.5 |
| X 10 | 11.5 | 19.0 | 15.0 | 12.0 | 10.5 | 12.0 | 80 0 |
| X-7 | 10 5 | 16,0 | 9.5 | 27 0 | 10.5 | 18.5 | 92.0 |
| X-5 | 11 0 | 19.0 | 12.5 | 22.0 | 19.5 | 12.5 | 96.5 |
| X-11 | 10.0 | 16 0 | 12.5 | 21.5 | 7.5 | 9 5 | 77.0 |
| F. F. 1 | 14.0 | 17.0 | 13.0 | 11.5 | 11.0 | 11.5 | 78 0 |
| I. P. 165 | 12.0 | 6.5 | 8.0 | 11.0 | 7.0 | 20 0 | 74·5 |
| Total | 114.0 | 163.5 | 109.0 | 166.0 | 119.5 | 139.0 | 811.0 |

*Table* 8.—Showing the yields (in seers), of straw of each variety, recorded per plot.

cent significant difference in the varieties, and gave a standard error of 11.22 per cent and a significant difference of 28.52. The conclusion, therefore, arrived at is as follows :—

| X-9 | X-1 | X-5 | X-7 | I. P. 52 | X-10 | F. F. 1 | X-11 | I. P. 165 |
|---|---|---|---|---|---|---|---|---|
| 117.5 | 111.5 | 96.5 | 92.0 | 84.0 | 80.0 | 78.0 | 77.0 | 74.5 |

It is interesting to note here that the results of the yield of straw in this experiment under tube-well irrigation is almost the opposite from those obtained in the experiment under sewage irrigation. An attempt will be made later in the general discussion to explain these results.

## DISCUSSION AND CONCLUSION

From the above data we note that while there is more or less an agreement, in the characters studied, in the results of the two experiments, there are, however, wide discrepancies in others. We find, for instance, that there is a general agreement in the results in the capacity of germination of the wheats tested on both the experiments, and a certain amount of agreement in the yield of grain data; but there seems to be wide discrepancy in the rust data as well as in the yield of straw data. The difference in the rust data may be due to the fact that the observations were made at different times for the two experiments, so that certain varieties which are resistant to certain earlier forms of rust in the beginning showed a high resistance when the observations were made. These results will be checked more carefully in the next wheat season. The data on the yield of straw may indicate the response which the different varieties have to varying degrees of soil fertility. That is, some varieties seem to have a tendency to produce more straw under soil conditions which are more fertile.

The data from the sewage area seem to indicate that I. P. 52, X-1, X-9 and X-10 are of the same class as far as the yield of grain is concerned. X-9 has a very inferior yield of straw as compared with I. P. 52 and X-1. This, however, may be a quality in favour of X-9 as it is sometimes desirable to have a variety which does not have too much vegetative matter under conditions of high fertility as this may lead to lodging and also to a greater incidence of rust. In fact, the data on rust resistance in the sewage experiment might have been affected by these conditions in the field.

The data of the yield of grain from the tube-well area while not showing a significant difference of X-9 from X-1, X-7, I.P. 52 and X-10, does show some superiority of the variety X-9 to all the rest. X-9 is, therefore, definitely one of the best if not the best of those tested. X-1 also seems to be a good wheat as its yield of grain as well as of bhusa in the tube-well area is next to X-9. X-7 may also be considered a good wheat as it has, in the tube-well experiment, out-yielded I. P. 52, a standard wheat, in both the yield of grain and bhusa.

Judging from the yield of grain only, the data from both these experiments indicate that the best wheats are X-9, X-1, X-7, I. P. 52 and X-10, and that those that may be considered inferior to the standard Government wheats namely I. P. 52, Cawnpore 13 and I. P. 165, are X-5, X-11, X-2 and X-8.

In order to arrive at a more satisfactory conclusion regarding these wheats and also in order that they may be identified easily in the field, a study of the morphology and habit of the wheats was made. A record of that study is given in table 9.

| Varieties. | Cracter awn. | Colour of glumes. | Glumes, glabrous or pubescent. | Height of plant. | Earliness. |
|---|---|---|---|---|---|
| X-8 | awnless | straw | glabrous | intermediate | medium |
| X-10 | awned | reddish | glabrous | intermediate | medium |
| X-7 | awned | straw | glabrous | intermediate | medium |
| I.P. 52 | awned | straw | glabrous | intermediate | medium |
| I.P. 4 | awnless | straw with reddish tinge | pubescent | intermediate | medium |
| X-9 | awned | straw | glabrous | intermediate | early |
| X-5 | awnless | reddish | slightly-pubescent | tall | medium |
| C. 13 | awned | straw | glabrous | intermediate | late |
| X-2 | awnleted | straw | glabrous | tall | medium |
| X-11 | awnless | straw | pubescent | very tall | late |
| X 1 | awned | straw | glabrous | intermediate | medium |
| F. F. 1 | awned | straw | glabrous | tall | medium |
| I. P. 165 | awnless | reddish-straw | glabrous | intermediate | early |

*Table* 9.—Showing certain morphological and agronomical characteristics of the wheats included in these experiments.

From this record, it is noted that of the more desirable wheats X-9, X-1, X-7, and X-10 are all awned, which is a character generally considered desirable by farmers. It seems also that X-9 is earlier in ripening than all the others recorded in the table above except I.P. 165. This is another point in favour of X-9.

Another observation made on these wheats is on the quality of the grain. Five groups of two of Agronomy special students were asked to independently evaluate the market quality of the grain of the varieties, which had been placed at random and without any indication of what the varieties were. The results of these observation are given below :—

| Students | VARIETIES | | | | | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | X-9 | X-2 | P. 52 | X-10 | X-11 | X-5 | X-7 | X-1 | X-8 | C. 13 | |
| A | 6 | 4 | 4 | 4 | 2 | 3 | 4 | 4 | 2 | 5 | 38 |
| B | 6 | 5 | 3 | 4 | 1 | 2 | 4 | 5 | 2 | 3 | 35 |
| C | 5 | | 3 | 3 | 1 | 2 | 4 | 5 | 2 | 4 | 33 |
| D | 6 | | 4 | 3 | 1 | 2 | 4 | 4 | 4 | 3 | 33 |
| E | 6 | | 4 | 3 | 3 | 2 | 4 | 4 | 4 | 5 | 35 |
| Total .. | 29 | 20 | 18 | 17 | 8 | 11 | 20 | 22 | 9 | 20 | 174 |

*Table* 10.—Showing the grades of the market quality of the grains of the varieties as awarded by agronomy special students.

On analysis the following conclusion was arrived at with regard to the quality of the grains thus evaluated :

| X-9 | X-1 | [X-2, | X-7, | C. 13] | P.52 | X-10 | X-5 | X-8 | X-11 |
|---|---|---|---|---|---|---|---|---|---|
| 29 | 22 | | 20 | | 18 | 17 | 11 | 9 | 8 |

These results indicate that X-9, the Vijaya wheat, is superior in the quality of the grains to all the other varieties thus evaluated.

From all these experiments, therefore, the conclusion that one may arrive at is that X-9, the Vijaya wheat, is a superior variety, as far as this locality is concerned and under conditions which prevailed this year. It seems to be superior even to its parent I.P. 52, a standard wheat of this province, and also C. 13 another standard wheat. This conclusion may be considered more conclusive if the results of the experiments in the next two crop seasons also bear this out.

ACKNOWLEDGEMENT

The writer conducted these experiments with the help of these Agronomy special students, G. P. Das, B. Pisharodi, G. C. Sen Gupta, B. K. De, and A. K. Das Gupta, who were responsible for recording the observations and who also analyzed the data under the direction of the writer. The writer is grateful to them and also to his assistants, B. K. Sahu and G. D. Singh, who helped in checking the statistical analysis of the data thus collected.

# STATISTICS IN RELATION TO THE SCIENCE OF CROP IMPROVEMENT (II).

## FIELD EXPERIMENTATION*

By

M. P. Singh, M. Sc.

Plant breeding procedure generally consists of, first, collection of a large number of plants representative of the varieties in an area, and second, their evolution, suited to the conditions of the tract, subsequently in successive generations, into superior types arising out of segregation from the initial heterozygous material. When a type is to be evolved through hybridization, in the event of the chances of selection being meagre, it will be recalled, that even in this method, selection is the main process that works, after the nature of the inheritance of a particular character has been studied. Selection necessarily involves comparison of the two means, which is often doubtful in view of the variations which enter into them. The means under comparison are composed of two kinds of variations : (1) those due to real or genetical causes when the samples belong to two different populations, and (2) those due to the environment. The latter source of variation generally recognised as environmental, is due to various factors such as soil fertility, weather vagaries, differential insect pest attack, disease incidence, etc., and is often quite considerable, appreciably influencing the means under comparison. As the environmental variation has been shown to be not connected with inheritance and is of not much value, it is necessary that the means under comparison be free from its influence. Any technique claiming to be efficient has got to minimise the errors due to the latter source, so that the variation due to the former which is heritable, can be more easily detected, as it isthis variation with which a breeder is primarily concerned in achieving his object. Therefore, the variation due to the environment has to be reduced to the minimum, or ways and

*Lecture delivered in the Colloquium of Agricultural Research Institute, Sabour, Bhagalpur.

means have to be adopted to successfully eliminate it. As complete elimination of the environmental variation is next to impossible, what can therefore be done is to minimise it. To do this, it is necessary to know the relative importance of the aforesaid factors that contribute towards the environmental variation, so that necessary steps to control them may be taken.

In an attempt to compare the performance of, say, six varieties of wheat, with a view to ascertain if the differences between their yield is due to genetical causes, the simplest method of testing will be of sowing each variety in adjacent plots of equal size on a uniform site, and to argue the merits of one variety over the other on the differences observed. This method of testing not only ignores the probable differences caused in yield of six varieties due to the change of site from plot to plot resulting from probable differential insect pest attack, but also ignores the most likely differences present in soil fertility between plots. Regarding the latter it has been the experience of almost all agricultural workers that it is the major source of environmental variation, so much so that the presence of a fertility gradient in a field is not uncommon. Application of the statistical theory to combat the major source of environmental variation was made, now more than fifteen years ago, by Fisher to solve the difficulty.

## How was the Difficulty Solved.

The problem of soil heterogeneity, the major source of environmental variation, was solved in a very simple though unique way. The mean of a variety from several small plots in a field is a better index of its productivity compared to the yield of a single equivalent large plot which is generally not representative of the site on account of the pronounced fertility differences invariably present. A still better idea regarding the productivity of the type can be had if the mean is arrived at from plots taken at random, as a little gain in one plot due to fertility differences is likely to be compensated by another. Now if there are several varieties under test and an idea regarding their productivity freed from soil fertility differences over an area is sought, it is necessary that the figures are arrived at from random varietal plots in the site, it being needless to point that each plot has to have equal dimensions. In order to make it possible, and to estimate the soil fertility differences of the site to be eliminated subsequently from the varietal comparisons, it is necessary that the varieties under test are arranged in sets, and each set is repeated in the area. To ensure that the varietal mean is arrived at from random plots of a variety, the allocation of the different varieties in the plots of a set (block) is made at random, that is, the different varieties in each block are randomised. Repetition of the blocks in the experimental side is technically known as replication. So what Fisher did, was to put each plot under a variety. Allocation of the different varieties in the various plots was at random, that is to say, the laws of chance in the process of allocation were allowed a full play. Each set or block thus formed was replicated as many times as could be possible in the experimental site.

Under this arrangement, as all the varieties are equally represented in a block (set), the average of the replications will give the idea of the yield of all the varieties freed from the effects of soil fertility. The variation in the block totals will give an expression of soil fertility in which the varietal differences do not enter, varieties being allocated at random in each block, and this can be eliminated as between blocks. Once the major source of variation due to soil fertility entering the environmental variation is eliminated, the accuracy of the varietal comparisons will naturally be increased. Minor variations do not matter as they are distributed at random between the variety plots, and a little gain in one, will be compensated in another as aforesaid.

## Analysis of Variance.

Replication in the Fisher's technique is the sole source of the estimate of variation. By randomisation the estimate of the variation is guaranteed valid. The technique which aims at separate evaluation of the components of variation is termed the analysis of variance. The variation due to replications (blocks) can be eliminated from the total variation by the analysis of variance as an extraneous source of variation, nothing to do with the varietal comparisons, although if the experiment had not been arranged in the way described above this would have effected the comparisons. The remaining variation is divisible into two parts, that due to treatments and the remainder attributable to causes beyond control (error.) The error component of variation, if the varieties had equivalent effects, is within certain limits generally equal to the treatment variation, but if the variation due to treatments is much greater than the error variance, and if there is a small probability of such a great variation occurring by chance, it can safely be assumed that the varieties differ significantly. What these significant differences are can be seen by comparing the varietal means by the help of the standard error calculated from the error variance. In order that the technique of the analysis of variance can be safely applied, it is imperative that the design of the experiment be such that the different sources of variation are capable of estimation without any entanglement, *i.e.*, the design of the experiment should be orthogonal. To put it more simply, every treatment should be tried equally in each block. Once the design of the experiment has been fixed there will be only one method of statistical analysis that will be valid. To summarise, replication, randomisation and block division are the main principles of design introduced by Fisher (1923.) Block division (Local control) increases the precision by eliminating the variation due to soil fertility which would have otherwise contributed towards the effect of the variety or treatment itself.

## Randomised Blocks.

In the foregoing paragraphs the principles described are those of randomised blocks. In this arrangement differences due to soil fertility in an experimental site can be efficiently eliminated from the total variation by dividing the site into several strips or blocks, and allocating at random, in each block, the various treatments to be tested. By virtue of this arrangement, the major portion of the soil variation is eliminated from the total variation as between blocks, and the minor variations in soil fertility within blocks is distributed at random between plots. It has been the experience of experimenters that with greater number of replications the comparisons are more accurate. Some workers are apt to object to it, on the ground, that with larger number of varieties and greater number of replications, the block size and consequently the area under experimentation, is quite considerable, and the fertility differences contribute substantially towards the error variance. With large number of varieties and inadequate replications error variance will really be affected as the treatment means will then be less stable being based on smaller number of plots; but with adequate replications this danger is removed.

The adequacy of replications on which is based the estimate of error, can be judged by considering the factors influencing the error variance. It is a known fact that error is affected directly by the number of degrees of freedom available for its estimation, and indirectly by the size and shape of the plots and blocks. Degrees of freedom for the estimation of error variance depend upon the number of varieties and blocks or replications, and care should be taken that the number of replications is not small. If a large number of varieties are under test, quite a good number of degrees of freedom will be available even if the number of blocks is

small, but as in this case the treatment means get affected as aforesaid, the blocks also have to be many. In general, for testing three or four varieties, employment of six to eight replications should be quite adequate.

The statistical theory has only very recently been applied in plant breeding work beyond the stage of variety testing, as a result of the evolution of progeny row technique of Hutchinson and Panse, and the results arrived at by this method are much sounder than before. The reasons which had discouraged breeders in the past regarding its earlier use in the initial stages of work have been enumerated by Hutchinson (1937) and they are, firstly, that in the earlier stages of work replicated experiments, due to the limitations of seed quantity from single plants, the method could not be found possible, and the second reason, which is quite a genuine one, is that in the initial stages of selection the material is so impure that it will contribute substantially towards the error variance.

The answers given to the objections are that in the former case "even with extremely small plots the error variance is not unreasonably high" to insure the efficiency of comparisons; and in the latter, the "Genetic variability will, of course, contribute to the error variance, and where there are no great differences in variability between progenies, there will be no risk of drawing erroneous conclusions. On the other hand, the estimation of genetic variance is a matter of first importance to the plant breeder, and for this reason the method of replication and randomisation is of value as much there is reason to believe that the material may be heterogenous in genetic variance as where it is homogeneous" (Hutchinson and Panse 1937.)

In plant breeding work the main aim is to secure a progressive improvement over the mean performance of the progenies by making use of the superior segregates arising from the initial heterozygous material. The facility of recognizing such types by the use of the principles of replication and randomisation will be appreciated as the comparisons will be based on a much sounder footing with very little chances of drawing faulty conclusions and the rate of improvement will naturally be much greater than if the method of replication and randomisation had not been employed.

With the isolation of the superior segregates very soon it becomes essential to recognise which of the material if selected is likely to respond to further selection and thus yield better results, and which of it is uniform and not likely to respond to selection. In other words it becomes necessary to estimate 'within plot variance' or 'genetic variability' for each progeny. Randomised blocks do not provide such an estimate for each progeny, they only provide an estimate of variance between progenies, but if families having several progenies, are available, the estimate of 'within families variance' between different progenies can be made by the help of compact family block design of Hutchinson and Panse (1937.) By virtue of this design it is easy to make up one's mind regarding the problems which face when the isolation of superior types have been accomplished, as families 'with high mean and high variability can be retained for further selection, families with high mean and low variability can be bulked for variety testing, and families with low mean and low variability can be discarded.'

The whole idea of plant breeding work is to evolve economic types better adapted to the ones already present in the tract. In order that the efforts may be really justified, it is imperative that the material arrived at by bulking is tested against a standard. There can be no better standard than *local* (the material cultivated by the cultivators) that can be adopted mainly on account of two reasons: firstly, that it is generally the local type which has to be replaced and the improved type has to show its superiority over it; secondly, it is important that the improved type should be sufficiently variable to make the improvement a lasting one, and there can be no better type as a standard than *local* which is the most adopted, to the varying conditions of the tract.

At this stage the limitations of the seed quantity are not so serious and larger plots can easily be adopted. With the use of larger plots it is natural to expect a greater degree of soil heterogeneity and for efficient comparisons it is imperative that it is properly handled by making use of the designs which control the magnitude of the error variance.

**Reduction of Error Variance.**

This is accomplished in various ways given under the various sub-headings.

(*a*) *Latin square* :—In the method of randomised blocks the variation due to soil heterogeneity is eliminated only along the various blocks. By having as many replication as there are varieties to be tested, or, so to say, by having as many blocks as there are varieties, the variation due to the soil fertility can be eliminated one along the blocks and the other along the plots, or along rows and columns as they are generally known. The process of allocating the various treatments is at random both in the rows and columns, and care has to be taken that a treatment occurs only once in every row and column.

Under this arrangement the soil variation is eliminated in two directions—along rows and columns, and the accuracy of the comparisons as compared to the randomised block design should be greater, as has been the English experience. In India Latin square has been employed only with a small number of treatments probably on account of a large area being involved with the use of a larger number of treatments, thereby crossing the limit of adequate management. Latin square could not find favour with the Indian workers as compared to randomised blocks on account of the greater flexibility of the latter. One big advantage of randomised block design is that for each comparison a separate estimate of the error can be made, and it is of great value when treatments having large differences are being compared. In the event of a complete failure either of a treatment or of a block, the analysis may be carried on the remainder of treatments or blocks, a facility which does not exist in the Latin square design. Besides the ease of working with the randomised blocks, Hutchinson and Panse (1935) have clearly shown the failure of the Latin square arrangement to give a lower error compared to an efficient randomised block arrangement. Latin square fails to give a lower error on account of in-efficient block shape represented by the columns, and the number of degrees of freedom available for the estimation of error are reduced without any corresponding reduction in the error variance.

(*b*) *Size and shape of plots and blocks* :—That the size and shape of the plots and blocks have a great bearing upon the elimination of soil heterogeneity has lead to comprehensive investigations into the problem. The size and shape of a plot and block are best determined by the help of a uniformity trial which consists in the determination of standard errors for different sizes and shapes of plots. The size and shape of a plot giving the lowest standard error and which are suitable for agricultural operations are generally choosen. The general principles which govern the shape of a plot are, that a plot should be of a nature which will sample nearly most of the soil variation in a block, and long and narrow plots running throughout the length of the block are the ones which do it adequately. For the block it is essential that it should be in a uniform soil representative of the tract. The blocks should differ from each other appreciably in soil fertility and thus be able to sample the experimental site. No block size can be fixed. In uniform soil conditions blocks of large sizes can be employed, but where the soil fertility is steep the block size has got to be small. As the block has to sample the experimental site, its shape, if a square one or very nearly a square, is advantageous, as it removes more of the soil heterogeneity compared to rectangular blocks, (Hutchinson and Panse 1935). Besides, a square has the least perimeter.

(c) *Uniformity trial*:—One use of such trial has already been shown above in determining the most advantageous plot size. Here other uses of such trials can be dealt with. In a randomised block design the accuracy of the comparisons will be greater when the different plots within a block do not differ considerably in soil fertility. In actual practice it is rarely realised, but it is possible to secure it to a considerable extent provided the yield of the pre-experimental period of a uniformity trial in the same site and with the same variety is known. It is accomplished with the help of a technique called the covariance as the pre-experimental figures of the uniformity trial are correlated with the figures of the experimental period. The allowance can be made for the initial differences in fertility among plots within blocks, and the adjusted figures can be used in making the final comparisons. The use of such method are known to have increased the precision of the experiments considerably. In the case of the annual crops where the fertility has been found to vary considerably from plot to plot and year to year, it has been the experience, that the precision gained by the use of the uniformity trial, in view of the expense and time, is not compensatory, and on account of this fact some workers question the utility of a uniformity trial preliminary to the main experiment, with a view to correlate the experimental figures with pre-experimental figures to increase the precision (Fisher). This, however, is not always true; and, under special circumstances, as in the case of perennial crops, where the yield of a plot is successively positively correlated, there is very little against the use of a uniformity trial. (Mahalanobis 1937.)

## Analyis of Covariance.

There are many other factors besides the final factor, the yield, that can be studied in an experiment. It is also generally found that the final factor (yield) is influenced by other factors, that is to say, they are correlated. To cite an example, the simplest case is that of yield and plant numbers. Yield is invariably dependent upon the number of plants that have established themselves. Yield comparisons irrespective of the consideration of plant numbers are not going to be so accurate as when the plant numbers have been accounted for. The simplest way of doing this will be to adjust the yields to equal plant numbers. This method though likely to improve the efficiency of the yield comparisons, will not account for the differences caused in yield on account of better productivity resulting from consequent vigorous plants due to the presence of gaps. This incalculable factor of the gaps in plant population resulting in yield variation, can be accounted for by the 'analysis of convariance' which is a technique aiming at evaluation of the variation occuring at the same time in two or more variables that are correlated. By the help of this technique, variation in one variate is adjusted for another; in the case of yield, for variation in plant numbers. That is, it finds out what the yield would have been, if there was no variation in plant numbers. The adventage therefore, in this method, is that the correction is made in the experimental data exactly as it arises in the field and not by any other artificial way. It is natural that with such an assurance the accuracy of the comparisons will be greatly increased; and it is on account of this that the method is getting increasingly popular with the experimenters. The same method can be applied in various ways to eliminate the influence of other factors as disease incidence, insect pest attack, tillering, etc., to improve not only the efficiency of the yield comparisons but also to find the effect of these factors on the material under test. In cases where a factor is influenced by superimposing other treatments, the application of the analysis of covariance is not justifiable. The simplest case to cite is that of germination and stand at thinning. For germination generally more than one seed is sown per hole to safeguard against consequent reverses in stand should the germination be defective; and when

the seedlings have established themselves, thinning to one strong seedling per hole is done.

In the analysis of covariance 'regression coefficient' is evaluated, which is the ratio between the dependent and independent variable showing the amount of change brought about in the mean value of a dependent variable when the independent variable is changed by unity.' In the above example of yield and plant numbers, yield is the dependent and the plant numbers the independent variable. The regression coefficient is not only extracted from the error variance but also from the treatment variance, thus giving a revised estimate of the error and treatment variance freed from the influence of the independent factor. If the regression is found to be significant, then the variation in plant numbers has been instrumental in effecting the yield and vice versa.

It will, therefore, be seen that a little statistical manipulation will lead to considerable reduction of the variance ascribable to the errors of random sampling. Which method to use will largely depend upon actual circumstances, and upon the judgment of the experimenter. Considerations of the plot size and the correlational analysis, however, have a universal utility and the adoption of these methods will go a long way in improving the art of field experimentation.

## Evaluation of the Interactions.

With the accomplishment of the isolation of a strain superior to local, new problems of paramount importance connected with the distribution of the new strain face the breeder. He is not only called upon to justify his efforts on a large scale but also has to point out the areas in which his types are going to be of any value. Being in the possession of more than one strain at that stage, it is difficult for him to make up his mind in favour of one or the other variety to suit the varying conditions of the tract he is serving.

Testing of the improved varieties singly at various places and seasons with a view to obtain answers to the problems referred to above will result in no end of experimentation, more on account of extremely variable edaphic and climatological factors. Besides, the results arrived at, will only be applicable to the conditions of the experiment. The need, therefore, of a technique capable of furnishing maximum of information in as short a time as possible is keenly felt and the want has been made good by evaluating the "interactions" or the "differential effects" between the various factors under test.

That the knowledge about the various interactions is as important as the main factors under test will be clear from the consideration of the example that 'the movement in a car is not only due to the action of pistons or petrol singly, but due to the differential action of all the parts of the internal combustion engine.' Sometimes the information regarding the interactions is even more important than the main effects especially when the performance of a variety in the presence or absence of a factor is needed—an information which can not be available when single factors are tested.

The idea of the evaluation of interactions has revolutionised the art of field experimentation, as not only the results arrived at are more comprehensive but also considerable saving of labour and expense is effected.

The question of labour and expense of testing single factors will be clear by considering a concrete example. Suppose the effect of four manures on four varieties is to be tested and separate experiments are to be conducted using eight replications. For varietal trial 4 x 8 plots shall be required. For testing o manures four experiments dealing with four varieties requiring in all 128 plots

and a total of 160 plots for manures and varieties shall be necessary. Now if it is combined in one design capable of evaluating interaction or (complex design) for 16 combinations of four varieties and four manures for 160 plots, firstly instead of eight, ten replications can be given in the same field and secondly, each manurial or varietal comparison will have 40 replications. If the standard error per plot remains the same as with eight replications when single factors were being tested, the accuracy of the comparisons of single factors in the complex experiment will be increased 5 times. Furthermore, the four manurial experiments cannot be tested directly in separate experiments, but they can be directly tested in a complex design. This is not all. Information regarding the interactions or in this case the response of the varieties to the manurial treatments is only possible in a complex design. Complex designs on account of their comprehensiveness are getting increasingly popular, but recently some objections against them have led to the development of new designs called the 'confounded designs'. The chief objections against the use of the complex design is that with the adoption of all the combinations which are rarely used in practice, the size of the block gets very large and the amount of soil heterogeneity encountered thereby is not efficiently eliminated, with consequent increase in the residual error. It is quite true that all the combinations used in the factorial design are seldom used, but it cannot be avoided ; and once the most useful combinations are discovered, the level of accuracy can be increased by eliminating those combinations by 'spliting of the plots'. It has also been the experience that the interactions of the higher order involving three or four factors are often insignificant and these interactions can be ignored or confounded.

## Split Plot and Confounded Designs.

At the cost of accuracy complete factorial designs can be employed but where it is known that either the high order interactions (interactions involving 3 or 4 factors) are insignificant, or will not be of much practical utility they may be confounded with the block differences and the level of the accuracy be increased at the cost of some information. The balanced set of treatments are, therefore, purposely allocated to two or more such blocks.

Split plot technique is a simple example of confounding. The design is particularly of use in cases where the nature of treatments is such that their application is inconvenient as in the case of irrigation treatments where considerable danger of seepage exists and the cultivation treatments whose application on small plots becomes cumbersome. It is also used in cases where differences between the main treatments are known and information is sought regarding the subtreatments. The main treatments are first laid out in randomised block design and then the different plots of the main treatments are further divided into sub-plots which are allocated at random to the different sub-treatments. Two errors, one for the main effects and the other for the sub-treatments, are evaluated in making the comparisons.

## Serial Experiment.

This is a recent development in Agriculetural exprimentation based on the principle that since the results are governed by so many factors as soil, climate, temperature, etc., which themselves are so very variable, the significance of the utility of these results remains problematical. The difficulty has been solved by conducting the experiment under identical conditions of block and plot size, in a uniform site, representative of the tract, in different places over a number of years where the application of the agricultural result has to be applied, and evaluating the interactions (Panse 1937) between places and seasons. One point worthy of notice and not

generally realised is that though the experimental site can be fixed, the experiment has to be laid out with fresh randomisation every year. Adopting the same randomisation year after year introduces bias making the analysis of variance invalid. The general procedure is to conduct the experiment for at least three years.

From the data thus collected the following analysis can easily be made :—

(*a*) Varieties.
(*b*) Places.
(*c*) Seasons.
(*d*) Varieties x places.
(*e*) Varieties x seasons.
(*f*) Places x seasons.
(*g*) Varieties x places x seasons.
(*h*) Error.

The interactions of interest to the breeder in connection with the information regarding the dsitribution of his varieties are (*d*) and (*e*). If the aforesaid interaction are found to be insignificant, and the variety mean square significant, it means that the varieties have maintained the same relative position throughout the different places and seasons, and are useful only for those seasons, where the experiment has been conducted. But when the interactions (*d*) and (*e*) are significant and the variety mean square shows significance compared to interaction mean squares, the most suitable varieties can be released for distribution with confidence that they will prove better in future seasons, as it means that the different varieties are suited at different places having responded to the various soil types in different seasons. It will therefore be seen that by evaluating the interactions how beautifully the varying nature of the edaphic and climatological factors have been tackled. Unfortunately, the above method of analysis is valid only when the error mean squares of the different experiments do not differ widely to justify a combined analysis. But when the error mean squares are widely different, combined analysis to evaluate the aforesaid interactions is not possible. Yates (1934) has suggested a method for such circumstances and it consists of testing the mean differences of pairs of strains for each trial at a time by a 'T' test. The error variance in this test consists of the interaction between experiments and strains which is the same as places and seasons. The significance of this interaction can be tested by a 'Q' test.

## Recoupment of Orthogonality. (Missing plot technique.)

It is not uncommon to experience in field experimentation the loss of the produce of one or more plots either due to inefficient working or due to the activities of insect pests or to disease incidence. The effect of such mishaps is that the layout gets non-orthogonal and as such the application of the method of analysis of variance invalid. Non-orthogonality can, however, be recouped by calculating the value of the plots thus lost by the help of the missing plot technique of Yates.

In case more than one plot is missing, the general mean value calculated from the data is substituted in all the missing plots save one whose value is to be determined. It is necessary to recalculate by the Yates formula the missing plot value by second approximation after substituting the value of the missing plot arrived after the first approximation.

## Concluding Remarks.

From the foregoing discussion it is obvious that statistics in the art of field experimentation plays no better part than that of a tool in the hands of the experimenter to make his results sound and comprehensive. The use of the tool (Statistics) has, however, to be made with some caution depending upon the

circumstances. Application of statistics in cases where simple experiments would serve the purpose will not only be expensive but useless. Elaborate comparisons and calculation of constants in the case of new introductions which have not yet proved their suitability to the new tract is meaningless, when better purpose can be served by simple observational plots which are meant to demonstrate the growth habits of the introductions, their resistance if any to the insect pest attack to which the local type is resistant, etc. Much of the material in this way can be cut down without taking resort to elaborate statistical methods.

Considerations regarding the adoption of local practice are of paramount importance and ought not to be lost sight of by the breeder, specially when it has been the experience that only that strain has any chance of success in a tract which has been bred under identical conditions of that tract (Panse V. G. 1937.) In order that the drawing of erroneous conclusion may be prevented and that the results of the field experiments may be valid it is imperative that the soil type on which the experiments are laid out is representative of the tract to which the results will be applied. Agricultural practices of rotation, manuring, cultivation should be strictly according to the local practice. Cultural practices of spacing, interculture and irrigations also have to be in conformity with the local practice of the tract. Results arrived at under elaborate system of farming with liberal applications of manures and irrigation will be useless as similar conditions can hardly be expected to be reproduced in the cultivators plots, where the strains have ultimately got to go. Only those practices should be allowed which will not seriously impair the local agricultural practice and will help in increasing the uniformity of the experiments.

For efficient experimentation it is needless to point out that all plots in a trial should receive identical agricultural treatment. Variations can only be allowed when they have been justified from previous experiments. Sowing should be accomplished in one date unless of course the experiment has been designed to test the different sowing dates. All operations in the experimental plots should be finished as early as possible ; and not more than two days should be allowed, as far as possible, for an operation to be completed.

Border effect has been shown to be considerable (Hutchinson and Panse 1935) in some crops and due non-experimental margins should be allowed all round each plot. Paths in between blocks serve no better purpose than merely affording an easy approach to the plots for inspection and they should be allowed only when adequate non-experimental margins have been provided for in the plots.

## REFERENCES.


1. Fisher R. A. Design of Field experiments.
2. ......................... Statistical methods for Research workers.
3. Hutchinson, J. B. and Panse, V. G., 1935—Ind. Jour. of Agri. Sci. V : 523.
4. ................................., 1937—Ibid.
5. Mahalanobis, P. C., 1940. Ind. Jour. Agri. Sci. Vol. X.
6. Panse, V. G., 1937. Pro. of the First Conference of Research Workers on cotton in India, 411.
7. Paterson, D. D. Statistics in relation to Agriculture.
8. Saunders, H. G. and Wishart, J. Principles and practice of field experimentation.
9. Wishart, J. 1934. Proc. of the 2nd Conf. on Cotton Growing Prob., London.

# SOME INVESTIGATIONS ON THE RELATIVE TOXICITY OF BORATE AND CHLORATE AS HERBICIDES.

BY

A. K. DHAR, B. Sc (AG)., M. Sc. (AG. BOT).

*Department of Agronomy, Allahabad Agricultural Institute.*

## INTRODUCTION.

The use of chemicals for controlling weeds was recognised for the first time during the last decade of the nineteenth century and in the early part of the twentieth. Except for a few selective sprays such as the sulphates of iron and copper which were used to combat certain annual weeds growing among grain crops, and a few other chemicals such as arsenical compounds, salts and oils which were used for killing weeds along paths, driveways and roads, little progress was made in the development of chemical weed control. Bolly (4, 5), Brenchley (6—8), Aslander (1, 2) were among the pioneer investigators in this subject. It remained, however, for later investigators like Johnson (16 offord (20) Ball, Madson and Robbins (3), Crafts (9—12), Long (13), Barnett (3), Hansen (14), and many others to look for newer developments in various phases of chemical weed control. Even fertilizers were tried to control weeds with varying degrees of success Singh and Das (21) reported partial success in controlling *Chenopodium album* and *Anagallis arvensis* with fertilizers like ammonium sulphate, sodium nitrate, etc., applied singly or in combination. Recent researches have brought to use a few other chemicals such as borates and chlorates which also produce similar results. But recently some organic chemicals have been produced by some commercial farms in the U. S. A., one of which is trichlorophenoxy acetic acid commercially known as TCP. This is claimed to control deep-rooted perennial weeds without any harmful resital effect. Some other chemicals have also come in the Indian market, which are in the nature of hormones, claimed to have similar results.

The results so far obtained with chemical herbicides, specially, chlorates arsenites, borates, etc., have been very largly varying. Different recommendations have, therefore, been made depending largely on more or less empirical results.

Some experiments, however, have clearly indicated that the effectiveness of chemicals are dependent on a number of factors—edaphic and environmental. Amongst others the condition of weather, the physical properties of soil, and the organic matter content of the soil, have been proved to be very important. As these vary from place to place, experiments were conducted at the Institute of Agricultural Research of the Benares Hindu University by the author at the suggestion of Prof. B. N. Singh and under the supervision of Prof. K. Kumar, and Mr. K. Das, to evaluate the influence of these factors, under the conditions prevailing there.

## EXPERIMENTAL PROCEDURE.

A pot culture experiment was designed to study the relative sterilizing effect of borate and chlorate on the farm soil. The biological method of testing toxicity was employed by growing wheat (T. vulgare), variety I. P. 52, as an indicator plant.

Earthen pots with a diameter of 1′ at the top and 5″ at the bottom and 1′ in height, were used for the experiment. The holes at the bottom of the pots were plugged with corks and the inside of the pots were painted with a thin film of molten wax so as to avoid leaching.

The treatments were replicated five times. The pots were arranged into two series of eleven rows with five pots in each row. The total number of the pots was 110.

Soil samples were collected from the college farm. The first 6" layer of the dry soil was taken from a ploughed field in November, 1943 The soil was pulverized to pass through a $\frac{1}{2}''$ screen. The pots were filled with this soil at the rate of 20 lbs per pot when completely air dry.

The chemicals selected for this experiment were borax (sodium-bi-borate) and potassium chlorate, as sodium chlorate which is more commonly used was not available due to war conditions.

The concentrations selected for both borate and chlorate were 0, 30, 60, 90, 120, 150, 300, 450, 600, 750 and 900 parts of dry salt per million parts of air dry soil the corresponding amounts of dry salts per pot being 0.00, 0.27, 0.54, 0.81, 1.08, 1.35, 2.70, 4.05, 5.40, 6.75 and 8.10 gms. Finely powdered salts were mixed with the soil in the pots and great care was excercised both in weighing and mixing with soil in pots.

Wheat (T. vulgare), variety I. P. 52, was used as the indicator plant and 15 uniform seeds were sown at uniform spacing and depth under ideal condition of soil and moisture on Nov. 15, 1943.

Watering was given every alternate day, after the seed have started germinating, with care, with a fine spray, and the water was not allowed to overflow the pots. Occasional weeding and shallow cultivation was given to pots.

The experiment was conducted for a month. The effect of the herbicides on the germination of seeds was first recorded on the 7th and then on the 15th day after sowing. The survival of the germinated plants in spite of the toxic effect exerted by the chemicals, was also taken on the 30th day after sowing. On this day the plants which still survived were carefully dug up, cleaned and washed. From each pot a plant was selected at random for recording various morphological characters such as height, number of tillers and number of green leaves. Dryweights were also recorded after drying them to a constant weight at 100°C. Only the records of germination, survival, and of dry weights are given in this paper.

## EXPERIMENTAL RESULTS.

A perusal of the germination record (Table 1) on the 7th day after sowing indicates that the germination of the indicator plants decreased significantly as the concentration of the salts in the pots increased In borate the germination went as low as 2.3 per cent with 900 p. p. m. as against 86.6 per cent in the lowest dose (30 p. p. m.) Chlorate, on the other hand, inhibited germination almost completely even with 450 p.p.m.; and above this concentration no germination occurred. It was thus apparent that for equal concentrations of the two, the toxic effect of chlorate was more pronounced than that of borate. When the second record of germination was taken on the 15th day after sowing, the results were almost similar.

A record of the number of plants that survived out of those which germinated, on the 30th day after sowing (Table 2), showed that no plants survived in chlorate series when the concentration reached beyond 150 p.p.m. per pot, but the lowest value (21.18) per cent recorded for borate was found to be equivalent to 900 p.p.m. of borate. Thus when some plants survived even with 900 p.p.m. of borate no survival occurred beyond 150 p.p.m. of chlorate.

The growth of plants as indicated by the height, number of leaves, number of tillers also showed similar results. However, an interesting result was obtained when borate was applied in smaller doses, namely, 30, 60 and 90 p.p.m. It was observed that the height, number of tillers, etc., increased up to the application of 90 p.p.m. of borate which became equal with the control in the still higher doses and then gradually decreased as the doses were further increased.

The effect on dry weights were also similar. All applications of chlorate

even in the lowest dose immediately depressed the dry weight and this became more pronounced as the concentration increased.

Borate, on the other hand, showed an increase in dry weight with lower doses; the maximum being noted against 120 and 150 p p.m. after which the curve began to fall.

TABLE 1.

*Showing the relative toxicity of borate and chlorate on germination of the indicator plants, on the 7th day after sowing.*

| Concentration in parts per million. | | Borate. | | Chlorate. | |
|---|---|---|---|---|---|
| | | No. of plants germinated (average of 5 pots.) | Percentage germination. | No. of plants germinated (average of 5 pots.) | Percentage germination. |
| Control | 0 | 13.2 | 88.0 | 13.4 | 89.3 |
| | 30 | 13.0 | 86.6 | 9.4 | 63.2 |
| | 60 | 12.0 | 80.0 | 5.0 | 33.3 |
| | 90 | 11.2 | 74.6 | 3.8 | 25.3 |
| | 120 | 10.4 | 69.0 | 3.6 | 24.0 |
| | 150 | 9.4 | 62.6 | 1.8 | 12.0 |
| | 300 | 7.4 | 49.3 | 1.6 | 10-6 |
| | 450 | 6.2 | 41.3 | 0.2 | 1.3 |
| | 600 | 3.8 | 25.3 | 0.0 | 0.0 |
| | 750 | 2.2 | 14.6 | 0.0 | 0.0 |
| | 900 | 0.8 | 5.3 | 0.0 | 0.0 |

The critical difference for borate—treated plants obtained on analysis was 2.02 plants and that for chlorate was 6.03, on a 5 per cent level of significance.

TABLE 2.

*Showing the relative toxicity of borate and chlorate by the survival of the indicator plants, 30 days after showing.*

| Concentration in p.p.m. | | Borate. | | Chlorate. | |
|---|---|---|---|---|---|
| | | Number of plants survived (average of 5 pots). | Percentage survival of the total germination. | Number of plants survived (average of 5 pots.) | Percentage survival of the total germination. |
| Control | 0 | 12.0 | 32.4 | 12.2 | 92 4 |
| | 30 | 10.8 | 83.0 | 6 8 | 72.3 |
| | 60 | 9.2 | 73.3 | 3.4 | 48 5 |
| | 90 | [illegible].6 | 80.0 | 2.8 | 45.1 |
| | 120 | 8.6 | 79.0 | 1.2 | 24.0 |
| | 150 | 7.8 | 74.5 | 0.0 | 0.0 |
| | 300 | 6.2 | 60.0 | 0.0 | 0 0 |
| | 450 | 5 6 | 70.0 | 0 0 | 0.0 |
| | 600 | 2 0 | 38.4 | 0.0 | 0.0 |
| | 750 | 1.2 | 26.6 | 0.0 | 0.0 |
| | 900 | 0.6 | 21.1 | 0.0 | 0.0 |

The critical difference for borate—treated and chlorate—treated plants was 2.87 and 2.11 plants respectively.

TABLE 3.

*Showing the relative toxicity of borate and chlorate by the dry weight of the survived plants,* 30 *days after sowing.*

| Concentration in p p.m. | | Borate. Weight in gms per plant average of 5 plants. | Chlorate. Weight in gms per plant average of 5 plants. |
|---|---|---|---|
| Control | 0 | 0.155 | 0.196 |
| | 30 | 0.240 | 0.088 |
| | 60 | 0.261 | 0.071 |
| | 90 | 0.267 | 0.043 |
| | 120 | 0.352 | 0.018 |
| | 150 | 0.355 | 0.000 |
| | 300 | 0.268 | 0.000 |
| | 450 | 0.201 | 0.000 |
| | 600 | 0.197 | 0.000 |
| | 750 | 0.148 | 0.000 |
| | 900 | 0.060 | 0.000 |

The critical difference for borate and chlorate treated plants was 0.018 and 0.021 respectively.

Experiments were also conducted to study the residual effect of the application of borate and chlorate. The results were almost similar and it was observed the toxic effect remained in the soil for quite a long time.

The effect of organic matter in reducing the toxicity was also studied. The results indicated that organic matter reduced the toxicity when lower concentrations of chlorate salt were used but with higher concentrations the effect was not appreciable.

## DISCUSSION.

A comparison of the relative effectiveness of borate and chlorate which were studied in the experiment reveals that chlorate is much more toxic than borate.

Germination was adversely affected by both the salts, and the higher the concentration the fewer were the plants that germinated. The concentrations not only affected the total germination but also influenced the length of the time required for germination. This higher concentration not only lowered the germination but also delayed it. A differential effect is, however, observed between the effects of the two, chlorate proving more toxic than borate.

Thus when records of germination, survival and morphological characteristics of the plants grown with these salts were studied, the conclusion was that chlorate proved to be definitely superior to borate in toxicity. It appears that the oxidising capacity of chlorate plays a more significant role than the direct toxic effect of the elemental boron in borax.

It is, however, of interest to mention that the present experiment with borate indicates that this chemical has not been as effective here as was shown by the results obtained by Crafts (11) in his extensive studies with several types of Californian soils. He reported that with Fresno sandy loam complete killing of the plants was found with 140 p. p. m. of borax, but with Stockton adobe clay it took 680 p. p. m. of borax to kill the plants completely, within one month. Other investigators like Haselhoff (15), Geigel (13), Johnston Dore (17, 18), Warrington (22) and many others obtained this result even with lower concentrations with boron. It was, however, accepted that pure boron is more effective even with lower concentrations than borax which has got only a smaller amount of boron in it, which is responsible for the killing of the plants.

Crafts (12), however, used borax as was used in this experiment. The difference in the results, may, however, be explained by recognising that different plants can tolerate different amounts of boron. It may be possible that the indicator plant used in this experiment had greater capacity for resistance than the Kanota oat plant which were used by Crafts as indicator plants. The toxicity was also different on different kinds of soil, hence the soils used here might have been of different types from those use by Crafts. The purity of salt might also have influenced the result.

## SUMMARY AND CONCLUSION.

A comparative study of potassium chlorate and borax as herbicides indicated that both the salts in higher concentrations effected germination. The herbicides not only decreased the germination but delayed it also. It was observed that chlorate salt was more effective in reducing germination than borate.

The result obtained indicates that chlorate salt even with a very low concentration (120 p. p. m.) is very effective in killing and destroying all plants within a very short time. Borate, however, requires a much larger concentration for the same result to be obtained and may not be even very effective or economical.

## BIBLIOGRAPHY.

1. Aslander, Alfred, 1926 — Chlorate as plant poison: Jour. Amer. Soc. Agron 18 : 1101 - 1102.
2. ...................... 1928 — Experiment on the eradication of Canada thistle. Jour. Agri. Res. 36 (ii) 915—934.
3. Baki, W S., B. A. Madson and W. W. Robbins, 1931. — The control of weeds: Calif. Agri. Expt. Cir : 54. 1.6.
4. Barnett, H. L. and H. C. Hanson, 1934. — Control of leafy spurge and review of literature on chemical weed control. N Dak. Expt. St. Bull. 227.
5. Bolly, H. L., 1908 — Weeds and means of eradication. N. Dak. Expt. Sta. Bull. 18.
6. Brenchley, W. E., 1914 — Inorganic plant poison and stimulants. 110 P. P. Cambridge University Press.
7. ...................... 1914 — On the action of certain compounds of Zinc, Arsenic and Boron on the growth of plants. Ann. Bot. 28 : 283—302.
8. ...................... 1925 — Spraying for weed eradication. Jour. Bath and Westand South. Count. Soc. 5(D).
9. Crafts, A. S., 1935 — Factors influencing the effectiveness of sodium chlorate when used as herbicide : Hilgardia : 9(9) 437—457.
10. ...................... 1935 — Physiological problem connected with the use of sodium chlorate when used as an herbicide. Plant. Physiol. 10 : 699—711.

11. ...................... 1935 The toxicity of sodium arsenite and sodium chlorate in four California soils. Hilgardia 9(9) 456—498.

12. ...................... 1936 The relation of nutrients to toxicity of arsenic, borax and chlorate in soils. Jour. Agri. Res. 58 (9) 637—671.

13. Geigel, A. R., 1935 Effectiveness of boron on the growth of certain green plants. Jour, Agri. Uni. Puerto Rico. 19 : 5—28.

14. Hansen, A. A., 1918 Canada thistle and methods of eradication. U. S. D. A. Farmers. Bull : 1002.

15. Haselhoff, E, 1913 Plant Physiol. Miller. pp. 385 (1938).

16. Johson, E., 1928 Recent development in the use of herbicides in California. Mon. Bull. Dept. Agri. Calif. 17 : 7—16.

17. Johnston, E. S. and W. H. Dore, 1928. The Relation of boron to the growth of tomato plants Sci. 67 : 324—325.

18. ...................... 1929 The influence of boron on the chemical composition and the growth of the tomato plant. Plant Physol. 4 : 31—62.

19. Long, H. C., 1934 Suppression of weeds by fertilizer and chemicals : 57 pp. England.

20. Offord. 1931 .........

21. Singh, B. N. and K. Das, 1938. Effectiveness of spraying with fertilizer for the control of weeds in arable land : Jour. Amer. Soc. of Agron. 30(6).

22. Warrington, K., 1923 The effect of boric acid and borax on broad bean and certain other plants. Ann. Bot. 37. 629—672.

# VERNALIZATION OF VEGETABLES.

By

S. R. Barooah, B. Sc. (Ag.), M. Sc. (Ag. Bot.)

*Agronomy Department, Allahabad Agricultural Institute.*

## INTRODUCTION

Vernalization, a phenomenon which results in early maturity of crops, has been explained in different ways by different biologists. Some attribute this phenomenon of early maturity to the exposure of seeds to different ranges of temperature and for varying periods of light. Others attribute this phenomenon to exposure of seeds to either one of these factors, that is, not to both at the same time. Others again claim that this phenomenon may be brought about by exposure of seedlings to different photo-periods. It is claimed that the effects on the seedlings thus exposed to different photo-periods is carried over to the later stages of the life cycle of the plant. This conclusion seems to have been arrived at by various workers such as Rasuma (1930-31) Lubimenko and Szeglova (1931), Kondo and associates (1932), and Cajlachjan and Aleksandrovskaia (1935).

Vegetables also come to the market during a particular season ; and, when the season is over, those vegetables are not seen in the market, however valuable they may be. This leads to scarcity of vegetables in certain seasons as most of them cannot be grown then. But when the vegetable season comes, the market is flooded with vegetables and prices go down. These problems are particularly urgent to the layman who needs vegetables throughout the year at reasonable prices. Several ways may be adopted in order to solve this problem. Firstly, the growing season of the plants may be reduced to give an early crop ; and,

secondly, the plants may be treated in such a way that they can grow during its off season. These are two possibilities, although yield may at the same time be affected adversely.

In order to test the above theory of the effect on the plant when seedlings are exposed to different photo-periods and in order to tackle the problem of continuous supply of vegetables this investigation was taken up. This is only a preliminary study with a view to explore the possibilities of vernalizing vegetables by exposing them to different photo-periods.

## EXPERIMENTAL PROCEDURE

Fig 1.
Apparatus for ligth expossure

Chillies (Capsicum annuum), lettuce (Lactuca sativa), tomato (Lycopersicum esculentum) and brinjal (Solanum melongena) were chosen as the material for the experiment. The seeds were obtained locally. They were sown in pots, fifty seeds in each pot. The pots were properly watered every day in the evening. The seeds germinated after 4 days. When the seedlings were 3 days old the pots were transferred to different places where arrangements were made for exposure to different light periods.

The length of exposures used were zero, six, eight, ten, normal (average 11 hrs. 5 mins), fifteen and eighteen hours, and were lobtained either by the addition of artificial ight or by lessen ing the normal daily exposure to sunlight. The longer duration plants were treated with light from 300 Watt Osram lamps fitted in a specially designed box (Fig. 1). The control set was exposed sto ordinary daylight. The short duration ets were exposed to day-light according to their respective requirements and the rest of the period they were kept in the dark room which was light proof.

## EXPERIMENTAL RESULTS

The plants exposed to the zero and six hour duration of light did not do very well, and all the plants died at an early stage ; so no record of these was kept.

All the plants were very small during the period of exposure ; so it was very difficult to take morphological observations. Hence the plants were allowed to grow and the observations were recorded by photograph. The experiment was continued only up to the transplantation stage.

*Brinjal*—The brinjal plants showed better growth with in-

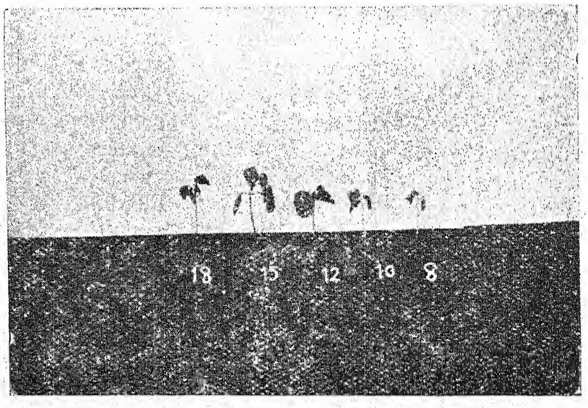



Fig. 2.
Effect of different photo-periods on the growth of brinjal plants. The numbers indicate the photo-periods.

crease in the durations of exposure up to 15 hours per diem. But when the day length was increased up to 18 hours a day, the growth of the plants was poor (Fig. 2).

*Lettuce*—The lettuce plants also showed the same type of growth as the brinjals. The growth of the plants increased with the increase of the photo-periods up to 15 hours a day, but when it was increased up to 18 hours a day the growth was poor (Fig. 3).

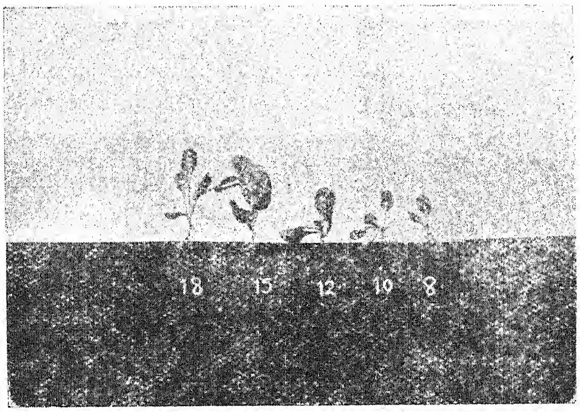



Fig. 3.
Effect of different photo-periods on the growth of lettuce plants.
The numbers indicate the photo-periods.

*Chillies*—The chillies behaved rather in a different way from the other two. The plants showed better growth with the increase in the photo-period, and the plants of the 18 hrs. duration lot showed the maximum growth (Fig. 4).

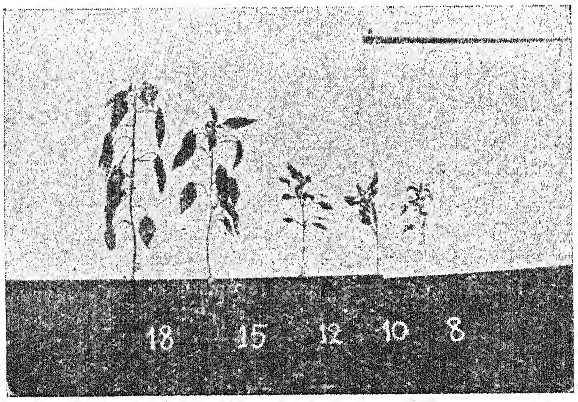



Fig. 4.
Effect of different photo-periods on the growth of chillies.
The numbers indicate the photo-periods.

*Tomato*—The tomato plants reacted the same way as the chillies. The increase in photo-period increased the growth of the plants, the maximum growth being shown by the 18 hrs. duration (Fig. 5).

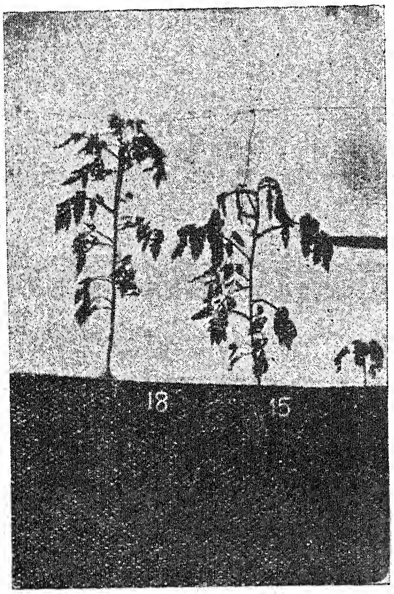



Fig. 5.
Effect of different photo-periods on the growth of tomato plants.
The numbers indicate the photo-periods.

As mentioned above, this was only a preliminary experiment in order to find out the reactions of different plants to different photoperiods under local (Allahabad) conditions Other plants, such as cabbages and cauliflower, were also tried, but they did not react to the treatment. This experiment shows a very high promise of the future possibility of vernalization of vegetables by photo-periods.

## Acknowledgments.

This work was carried out at the Allahabad Agricultural Institute with the help of the Harvard Yenching Fund. I am grateful to the committee which granted me a part of the fund to carry on the work. I am also grateful to Professors B. M. Pugh and W. K. Wesley for encouraging me to do this work, and to Mr. S. U. Patel in helping me in the carrying out of the experiment.

# MANURES AND MANURING

SUDHIR CHOWDHURY

## Chapter VIII

### SEA-WEED AND WATER HYACINTH

The use of sea-weed as a manure was already well known to the early Romans as is shown by the writings of Palludins who stated that after washing with fresh water, it can take the place of manure with other substances. Sea-weed has long been used for manurial purposes in the Islands of Thanaet and Jersey in the Hebrides, in Scotland, England, Ireland, Sweden, Japan and elsewhere.

**Chemical Composition :**

Most of the earlier analysis of sea-weed were of the ash rather than of the entire plant. Dr. Forchammer made complete analysis of the ashes of many genera and species of sea-weed. Amongst his determinations are the following :

| | Fucus digitatus | Fucus vesiculosus | Fucus serratus |
|---|---|---|---|
| Potash .. .. .. | 20.66 | 13.01 | 3.98 |
| Soda .. .. .. | 7.65 | 9.54 | 18.67 |
| Magnesia .. .. .. | 6.86 | 6.12 | 10.29 |
| Lime .. .. .. | 10.98 | 8.36 | 14.41 |
| Phosphoric acid . .. .. | 2.36 | 1.16 | 3.89 |
| Sulphuric acid .. .. .. | 12.33 | 24.06 | 18.59 |
| Ferric oxide .. .. .. | 0.57 | 0.28 | 0.30 |
| Silica .. .. .. | 1.44 | 1.15 | 0.38 |
| Sodium chloride .. .. .. | 26.18 | 21.48 | 16.56 |

The following analysis by Wheeler and Hartwell show the composition of several different varieties of sea-weeds following the rinsing off of the salt water and the removal of the superficial moisture :

| | Water | Nitrogen | Phosphoric acid | Potash | Lime | Magnesia |
|---|---|---|---|---|---|---|
| Laminaria saccharina .. .. | 88.0 | 0.17 | 0.05 | 0.16 | 0.38 | 0.17 |
| L. digitata .. | 87.5 | 0.23 | 0.06 | 0.31 | 0 41 | 0.22 |
| Rhodymenia palmata .. .. | 86.3 | 0.37 | 0.09 | 1.07 | 0.46 | 0.09 |
| Ascophyllum (Fucus) nodosum .. | 77.3 | 0.24 | 0.08 | 0.64 | 0.48 | 0.35 |
| Fucus vesiculosum .. .. | 76.6 | 0.38 | 0.12 | 0.65 | 0.45 | 0.31 |
| Phyllophora membranifolia .. | 66.2 | 1.08 | 0.14 | 0.96 | 5.11 | 0.69 |
| Chondrus crispus .. .. | 76.0 | 0.57 | 0 13 | 1.02 | 0.49 | 0.33 |
| Cladostephus verticillatus .. | 71.2 | 0.45 | 0.22 | 1.42 | 0.87 | 0.36 |
| Polyides rotundus .. .. | 58.5 | 0.70 | 0.16 | 1.45 | 0.37 | 0.46 |
| Ahnfeldtia plicata .. .. | 59.0 | 1.35 | 0.25 | 0.59 | 0.98 | 0.29 |
| Zostera marina .. .. | 81.2 | 0.35 | 0.07 | 0.32 | 0.51 | 0.32 |

## Practical Utilization :

Sea-weed decomposes readily in the soil and exerts its manurial effects chiefly in the first season. For grass lands it can be used as a top dressing but, as a rule, it is better to apply sea-weeds to lands that are about to be ploughed. In some parts of Rhode Island sea-weed is generally considered preferable to farm manure in so far as concerns its effects upon the smoothness of the potato tubers, but in regard to the cooking qualities of the tubers, unfavourable results from its use have been reported. Studies at the Rhode Island experiment station have shown that the difference in the smoothness of the potato tubers is due to the alkaline effect of the farm manure on the land which creates conditions favourable to the development of potato scab, whereas common salt and other chlorides such as are associated with sea-weed have the opposite tendency.

Concerning the effect of sea-weed on the quality of the potato tuber, it must be borne in mind that if it is not leached before application to the soil, it carries with it common salt. Schult, Salfeld and other German experimenters have shown conclusively that the application of chlorides just before planting the potato crop, results in a depression of the starch content of the tubers, increasing at the same time their nitrogen content and causing the frequent development of a soapy taste.

On account of the adhering sea-water, sea-weed may also be injurious to hops, to the burning quality of tabacco, and may depress the sugar contents of beets. It is recommended, therefore, to allow the sea-weed to be leached by rain before applying it to the land.

## Sea-weed compared with Farm Manure :

Sea-weed is comparable as a manure with farm manure though slightly deficient in phosphates. In field experiments it has been found that sea-weed gave, with potatoes, quite as good results as an equal weight of farm manure. It has the advantage over farm manure, of being more easily fermented and quite free from the seeds of weeds which are often abundant in the latter product.

## Composting Sea-Weeds :

Sea-weeds are composted to a considerable extent on the coast of Brittany, France, Sweden and other cold countries. They are often piled in layers, each from 6 to 8 inches deep, with a quantity of lime scattered between them. The pile then turned over occasionally, and at the end of from 2 to 3 months, when

well-rotted it is ready for use. Sea-weeds are also often composted with farm manure, but whatever the method followed it is a wise plan to keep the pile covered with at least a thin layer of moist soil in order to prevent the possible loss of ammonia.

## Sea-weed not a well-balanced Manure :

It is well recognised that sea-weed is not a well balanced manure for all soils and crops, and that to supply the needed amount of phosphoric acid in sea-weed, in all cases, would result in a frequent waste of potash or nitrogen or of both. On this account sea-weeds should be supplemented by bone-meal, basic slag meal, acid phosphate or other phosphatic manures.

## Water Hyacinth :

The analytical figures detailed below indicate that water hyacinth (*Eichornia crassipes*) contains considerable stores of valuable plant food of which potash is the chief constituent. If rotted, the residue contains about the same amounts of nitrogen and phosphoric acid as, perhaps more than, ordinary farm manure and is approximately five times as rich in potash as farm-yard manure containing a similar perceutage of water.

The composition of water hyacinth and cowdung on a common basis of 65 per cent moisture for comparison is given below :

| | Nitrogen | Phosphoric Acid | Potash | Organic matter |
|---|---|---|---|---|
| Water hyacinth (*Eichornia crassipes*) normal size .. | 0.45 | 0.32 | 2.52 | 27.95 |
| Water hyacinth (*E. crassipes*) large size .. .. | 0.60 | 0.23 | 2.61 | 27.95 |
| Cowdung (Voelcker) .. .. | 0.56 | 0.20 | 0.50 | 25.56 |

Water hyacinth is apparently not as rich in potash as the best marine sources of kelp. For instance, Hendrick gives roughly 28 per cent. as the average total ash content of the dry matter of *Laminaria digitata* (stems and fronds). For *Fucus* the average total ash content in the dry matter is about 20 per cent and the corresponding figure for dried hyacinth also approaches 20 per cent. On the other hand, the percentage $K_2O$ content of hyacinth ash (average about 25 per cent) appears to be nearly equal to that of *Laminaria* (26 per cent) and decidedly higher than *Fucus* (15 per cent). Of course, the kelp also contains iodine, which is a valuable constituent, but the respective problems involved in the use of see-weed and of water hyacinth either as organic manures or for the production of ash, are not dissimilar.

The high potash content of these weeds is of considerable importance in North-Eastern India where the soils of the old alluvium are, on account of the leaching effect of the heavy rainfall, generally deficient in lime, potash and phosphoric acid. The results of field tests show conclusively that water hyacinth is a valuable manure either in the rotted state or as ash. On the high, light, well-drained soils the rotted material might be preferable but on heavy low-laying lands the ash would probably be more successful.

It is worth remembering that if the fresh green plant be immediately stacked for rotting, a very serious loss of valuable material takes place in the liquid exuded during the rotting process. To prevent this, either the whole of the plant should be dried for a few days before stacking, or the fresh plant may be stacked in alternate layers with dried plant ; a similar result would be obtained by mixing the fresh plant with earth or with dried weeds.

**Water hyacinth serves a suitable raw material for composting.**